

Examining the Affordances and Constraints of Using Infographics in Pre-Service Teacher Education

by

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Abstract

Infographics are a communication tool that can be used to share large amounts of data in a more aesthetically pleasing and cognitively manageable way. The production and consumption of infographics encourages the development of many skills that have been deemed as crucial for students to develop in school including digital literacies, twenty-first century competencies, and multimodality. This study aimed to investigate how four students in a pre-service education program in Southern Ontario, Canada, perceived both the affordances and constraints of the use of infographics in their teaching. Using a mixed methods approach, Likert-style data, along with in-depth content and multimodal analysis of infographic artifacts and interview transcriptions, this research investigated whether or not infographics could aid teacher candidates in their development of digital literacies, twenty-first century competencies, and multimodality skills. Additionally, through the four phases of this research study, teacher candidates were able to explore their opinions about infographics and their potential future use in their teaching practice. This study proposes a new Infographic Matrix that could be used by educators to better embed this communication tool into their classrooms. Through the consumption and production of infographics there were positive impacts that resulted for the teacher candidates, both with regards to professional development as well as personal growth as a learner. This research aimed to lessen the gap that currently exists in this area of education research, as well as offer the teacher candidates pedagogically impactful approaches to literacy education for use with their future students.

Keywords: infographics, digital literacies, K-12 education, pre-service teacher education, mulitmodality, twenty-first century competencies, global competencies, literacy education

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1 Introduction

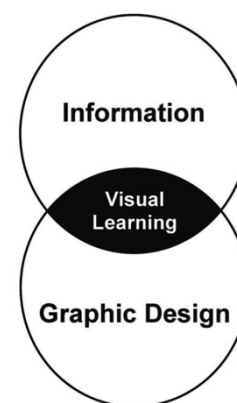
1.1 Overview

Infographics, an increasingly popular communication medium, act as a means of “taking complex ideas and information and representing them in a visual format that is clearly and quickly understood” (Thompson, 2015). These are valuable learning tools as they take a complicated set of data and convert it into a more manageable and digestible bite for readers. People tend to be drawn to infographics as they contain visualizations, colours and images, which are appealing to audiences (Kos & Sims, 2014). Infographics serve to bridge the gaps between the varieties of modes available to foster communication, and their digital nature enables the growth of digital tool skill sets. Although we are consuming vast amounts of information via infographics, particularly in the online realm, there is a dearth of research regarding the educational potential of “reading” and producing infographics, particularly in the area of literacy education.

Images, icons, and graphics have been used for centuries to describe information. Today, infographics are utilized in traditional media platforms like newspapers, magazines as well as during news broadcasts and throughout social media (Smiciklas, 2012). Infographics, based on the convergence of information and graphics, are a means to simplify and summarize complex information in an accessible and digestible manner. The purpose of infographics, according to Reavy (2003) and Lankow, Ritchie & Crooks (2012) is to provide a clear, and easy-to-digest explanation of information being shared with the

reader. A well-designed infographic should clarify information and pique interest in a subject area as well as encourage further research on a given topic (Siricharoen, 2013).

Visualization of information has been an asset to the mass consumption of material from the media. Consumers of knowledge look to absorb and engage information quickly and efficiently, utilizing the processing power of the visual systems in the brain (Lankow, Ritchie & Crooks, 2012) compounding with information that the individual already has stored (Trumbo, 1999). Figure 1 emphasizes the coming together of information with the properties of graphic design to elicit better overall visual learning and understanding. When graphic design elements like spacing, use of white space, font, and colour are considered, the artifact in question becomes more thought provoking and thus memorable, aiding in the ability to recall information from the graphic (Smiciklas, 2012). Through the adoption of infographic tools in the classroom, students can begin to acknowledge the importance of these design elements in their learning, and can use them to adopt the role of producer rather than consuming information. By encouraging the development of these requisite skills earlier in their educational journeys, students will cultivate more multiliteracies skills (New London Group, 1996; Cope & Kalantzis, 2000; Unsworth, 2001) that will aid them in the better understanding of material from literary texts.



*Figure 1: Visual learning
(Smiciklas, 2012)*

Teachers are always trying to find novel ways to improve their practice to constantly engage their students. Through infographics students are able to express their knowledge and understanding in new and interesting ways. More specifically, narrative

infographics are a design-focused method for students to inform their audience in an entertaining and illustrative way. Narrative infographics use graphic elements of design, specifically static images like drawings, charts, photos, or graphics, to communicate specific information in a way that is impactful and meaningful to the reader (Clark & Mayer, 2011; Lankow, Ritchie & Crooks, 2012). The multimedia impact, proposed by Clark and Mayer (2011), emphasizes that people tend to learn more profoundly when information is presented as both text and visuals when compared to text alone. However, it is important to differentiate useful graphics from “chartjunk” (Tufte, 2001), or any sort of graphic element that is unnecessary or does not communicate information to the reader.

With the use of infographics, teachers can utilize skills typically found in arts education to enhance the learning of statistical-based learning (Davidson, 2014), making subjects like math and the sciences more comprehensible to students. This may enable teachers to integrate the STEAM (Science, Technology, Engineering, Arts, Mathematics) movement into a classroom, rather than simply STEM. These subjects often incorporate a lot of data, which here means any measurable forms of information (Lankow, Ritchie & Crooks, 2012), which are often complex in nature relying on an understanding of numerical knowledge. In order for infographics to be effective as tools to improve literacy, they need to serve three main functions; they need to be appealing, understandable and meaningful (Lankow, Ritchie & Crooks, 2012). Students should be engaged by the look of the infographic, able to comprehend the information being presented to them, and the infographic should increase retention by being memorable. The interactive nature of the inquiry-based learning environment encourages active involvement from the students and thus works in tandem with introducing new ways to accomplish new literacy tasks,

including reading and creating infographics. Infographics enable this active thought and production of a final artifact rather than students just being receivers of knowledge. By encouraging the inquiry process, students can formulate ideas and conduct research on topics that are meaningful to them in a curricular-based and curiosity-driven assignment.

1.2 Previous Research and Problem Areas

While there is some research about the efficacy of infographics with regards to communication (Smikiclas, 2012; Siricharoen, 2013), research into the potential of infographics in the field of education has yet to gain similar momentum. Although infographics are gaining popularity through their ease of distribution and accessibility on social media as well as traditional media, a lack of academic research related to their potential for student learning and teaching makes it much less likely that infographics will be used in K-12 classrooms. Minimal research (Kos & Sims, 2014; Thompson, 2015) could be found examining the benefits and drawbacks of the use of infographics in the K-12 classroom. This study aims to begin to identify the affordances and constraints of infographic use in the kindergarten to grade 12 educational systems.

1.3 Research Goal

The current study investigates the use of infographics with teacher candidates to support their learning of twenty-first century and digital literacies skills. Specifically, the research seeks to identify teacher candidate attitudes towards using infographics in the classroom and the potential for this communication tool to be used in their future practice.

2 Literature Review

2.1 Overview

From a more traditional standpoint, literacy education used to focus on reading and writing, which were isolated from social processes (Gee, 2000). Research in literacy education emphasized the interconnected nature of these literacy related skills and the importance of integrating other representational means to create deeper meaning (Bakhtin, 1986; Gee, 1996). With this paradigm shift towards a New Literacies approach (Lankshear & Knobel, 2003; Street, 2003; Leu, Kinzer, Coiro & Cammack, 2004; Albers & Harste, 2007, Knobel & Lankshear, 2007), academics and educators are looking for new methods to not only teach the traditional and fundamental literacy techniques, but also engage the wider variety of skills that students now require because of technological advances in industry and the workforce.

The first section of this literature review will focus on terms of relevance, including digital literacies, along with the production and consumption of media. Section two will review the role of infographics through the themes of communication, interpretation, as well as visualization and learning. From the research conducted on New Literacies (Lankshear & Knobel, 2003; Street, 2003; Leu, et al., 2004; Albers & Harste, 2007; Knobel & Lankshear, 2007) the field has expanded to include topics including multiliteracies, twenty-first century competencies, multimodality in the digital literacies classroom, as well as infographics as a medium for communication, which will be discussed in the final consolidation section of the literature review.

2.2 Terms of Relevance

2.2.1 Digital Literacies

In a digital world, it is imperative that teacher candidates develop digital literacies skills (Beazley, McLeod & Lin, 2008; Judge & O'Bannon, 2008; Lund, Furberg, Bakken & Engelién, 2014). Digital literacies is defined as being able to use digital tools but also adapt their use in particular circumstances to meet the needs of the user (Eshet-Alkalai, 2004; Knobel & Lankshear, 2007; Jones & Hafner, 2012; Barton & Baguley, 2014). Digital literacies – including creation, construction, culture and cognition – have been emphasized as central twenty-first century skills to be developed by students in the classroom (Jewitt, 2008; Binkley, et al., 2012). Students need to be able to successfully communicate through multimodal methods to convey meaning (Jewitt, 2008), so through interacting and communicating multimodally, students are being better prepared to be adaptable communicators (Dusenberry, Hutter & Robinson, 2015). By providing the teacher candidates with an approach to encourage this type of communication from their future students, the TCs are being set up for greater successes in their classrooms.

The research to date extensively covers the pedagogical benefits of students being exposed to not only oral and print literature, but to multimodal works as well (New London Group, 1996; Lankshear & Knobel, 1998; Cope & Kalantzis, 2000; Kress, 2000, 2003; Knobel & Lankshear, 2007; Hughes, 2009). Regardless of this research though, students are still underusing these digital literacies skills even though many of them possess the capability to do so (Alvermann, 2002; Gee, 2003; Kress, 2003; Hughes, 2009). With access to online freeware that promotes multimodal communication, whether through

infographics or otherwise, students are better able to put their digital skills to use, both as creators and consumers of online media. In *A Rich Seam*, the authors outlined how new pedagogies encouraged teachers to address learning in a new light, by using technology not as a supplement to learning, but as a tool that is pervasive to the learning experience (Fullan & Langworthy, 2014). Their findings were summarized in Figure 2.



Figure 2: Summary of new pedagogies (Fullan & Langworthy, 2014, pg. 3)

Like many authors researching digital media and education, Fullan and Langworthy (2014) recognized the reach that these tools can provide students. With the click of a button, students can address real-world problems across a vast array of audiences as they extend far beyond the four walls of the classroom (2014). Educators and students are no longer limited by the boundaries of the classroom, they are able to consume and produce knowledge and content that has a global impact and reach.

2.2.2 The Prosumer Movement and Participatory Culture

With the explosion of Web 2.0, the prosumer movement was born (Toffler, 1980), encouraging web audiences to not just passively absorb information from the online world, but to actively contribute to the knowledge economy as well (Buckingham, 2007b; Greenhow, Robelia & Hughes, 2009). Toffler (1980) describes the term prosumer as the blurring of the lines between a producer and consumer to meet the growing demands of

the individual buyer. As a prosumer, individuals could produce their own goods and services to meet the growing needs of the online market. With the aid of technology, personalization and remixing of existing media and goods would become more readily available and feasible for the everyday buyer. Through tools like wikis, blogs, video sharing and social networking sites, students are shifting the focus of literacy education towards one that is more collaborative and multimodal (Jenkins, et al., 2009; Bloom & Johnston, 2010).

According to Jenkins (1992), participatory culture inspired individuals to become more familiar and interactive with texts, especially in online environments, which combine elements of image, words, video, and sounds (Hughes, 2007). This requires them to be able to navigate literature across multiple modalities, using multiple skill sets. These may include, but are not limited to, the critical analysis and creation of multimodal texts that incorporate visual, textual, digital, dramatic, and new literacies (Albers & Sanders, 2010). The current research made it clear, that modern-day literacy is created through an interdependent relationship that exists between modes (gestural, textual, digital, visual, musical), media (film, television, radio, written), and language (movement, written, oral, mathematics, coding) (Jewitt, 2008; Albers & Sanders, 2010). Through multimodal instruction, educators need to plan their programs in such a way that not only fosters the development of these skills, but also allows students the opportunity to interact with and experience successful iterations that fosters them in the learning environment.

2.3 Relevant Themes

2.3.1 Communication

Literature in the field of education already emphasized the importance of multimodal communication (New London Group, 1996; Kress, 2000, 2003; Nixon, 2003; Alvermann, 2009, Albers & Sanders, 2010; Hughes & Tolley, 2010; Jocius, 2013; Eteokleous & Pavlou, 2015), while also expanding to include visual communication (Avgerinou & Pettersson, 2011; Matrix & Hodson, 2014), along with digital and/or online communication (Cope & Kalantzis, 2000; Chandler-Olcott & Mahar, 2003; Mills, 2010; Cooper, Lockyer & Brown, 2013). Digital media offers the opportunity for students to communicate more effectively when compared to when they identified as having difficulty with traditional paper-based written assignments (Alvermann, 2009). Through tools like infographics, authors are challenged to take vast amounts of complex information and present it in a way that is consumable and approachable to the average person (Smiciklas, 2012; Toth, 2013; Lyra, Isotani, Reis, Marques, Pedro, Jaques & Bitencourt, 2016; Ozdamli, Kocakoyun, Sahin & Akdag, 2016). Since Web 2.0 has provided the affordance of mass sharing of content and information, providing audiences, whether students or the general public, with opportunities for more appealing and efficient information processing, infographics are becoming a welcome tool for communication (Locker & Kienzler, 2012; Toth, 2013).

With access to the Web, the ability to communicate and share content with a wider audience has become much easier for individual creators and has become a cultural norm (Belk, 2014). As users sift through Twitter or Facebook feeds, they are likely to come across a plethora of information being shared (Leonardi, 2017), whether through textual posts or embedding content like photos, videos, and infographics (Greenhow & Lewin, 2015). This

multimodal expression has forced educators and students to consider how to become better at communicating and decoding information in this type of environment (Kereluik, Mishra, Fahnoe & Terry, 2013). Since these competencies need to be taught in the classroom, this thesis works to identify specific challenges and skills that teacher candidates should improve upon so that they can better educate students in their future practice.

2.3.2 Student Engagement

There is an undeniable relationship between success in the learning environment and engagement with what is being taught (Nelson Laird & Kuh, 2005; Robinson & Hullinger, 2008; Chen, Lambert & Guidry, 2010). According to Marks (2000), student engagement can be defined as “the attention, interest, investment, and effort students expend in the work of learning” (p. 154-155). However, the distinction does not stop there, researchers have further broken down the idea of engagement into cognitive, emotional, and behavioural (Fredricks, Blumenfeld & Paris, 2004). According to the research conducted by Fredricks, et al. (2004), cognitive engagement involves the effort that learners put in to successfully comprehend what is being taught, which includes skills like self-regulation and metacognition. Emotional engagement centers on the learning experience, including feelings of boredom, interest, and levels of frustration. Finally, behavioural engagement refers to observable behaviours including presence in the classroom, task completion, and levels of participation (Fredricks, et al., 2004; Henrie, Halverson & Graham, 2015). Through the effective use of technology in meaningful activities, like infographic production, teachers are able to leverage students’ interests in these tools, and apply that towards success in the classroom (Sadik, 2008).

Today's students provide an interesting challenge for teachers, in that they have grown up in a society dominated by constant engagement. Whether it is through video games, television, music, or otherwise, students are being inundated with content throughout their day, so it is not unreasonable that they have similar expectations within the classroom walls (Prensky, 2005). When it comes to the classroom, students want to be intellectually stimulated; they want to be challenged by the tasks and information being provided to them (OISE, 2011a). In a study conducted by the Canadian Education Association (CEA), they found that only 37% of students felt intellectually engaged by what they were being taught in the classroom (Dunleavy, Willms, Milton & Friesen, 2012). Dunleavy, et al. (2012) used three measures to identify intellectual engagement: 1) interest and motivation, 2) effort, and 3) quality instruction. There is a correlation that exists between student engagement levels and teaching methods, so when students are taught with multiple tools and techniques, they tend to learn better (OISE, 2011b). It is clear that intellectual stimulation and engagement contribute to key developmental outcomes for students (Dunleavy & Milton, 2010; Dunleavy, et al., 2012). When students are emotionally and cognitively engaged in what they are being taught in the classroom, they are often more successful with their educational outcomes.

2.3.3 Visualization and Learning

It has been shown through past research that many students prefer having visuals embedded into their learning (Miller, 2001; Vanichvasin, 2014; Sousa, 2017), with Smiciklas estimating that as many as 65% of people identify with this learning preference (2012). Roughly 50% of the brain is dedicated to some form, either direct or indirect, of visual functions (Smiciklas, 2012). The neural network that exists to support the visual

system is vast and is one of the most heavily relied on by the human brain. The neurons responsible for the processing of visual activity account for approximately 30% of the total grey matter found in the brain (Smiciklas, 2012), which also accounts for the large capacity for storage and recall of the visual memory system in the brain (Sousa, 2017). Words, letters and numbers are all symbols, which require decoding from the brain to make sense of the incoming data. This decoding process requires the understanding of the symbol, how the symbol fits into a larger word and then how the words come together to form meaningful sentences. This idea comes from the psychological Cognitive Load Theory, which allows learners to focus on various areas of learning without overwhelming the capacity of the brain (Sweller, 1988; Lyra, et al, 2016). Though this does occur in milliseconds for most people, the amount of mental effort required for this type of decoding is much greater than the processing of a visual image (Smiciklas, 2012). Additionally, factors like letter size, case usage, and font have large impacts on the ability of a learner to process textual input, making the decoding process more mentally demanding, where the variants in images seem to have less of an overall effect (Pegado, et. al, 2014).

With these factors in mind, it is clear how infographics can bridge the gaps in the current system of learning for students who identify with multiple learning preferences. Infographics bring together multiple modalities in hopes that a wider audience, regardless of their propensities for learning, will understand them. Infographics use text and illustrations or images to inspire readers to retain the information being presented better (Lyra, et al., 2016). However, it is important to note still that regardless of the way that students prefer to learn, infographics act to encourage general visual literacy skill development amongst all learners (Thomas, Place & Hillyard, 2008; Matrix & Hodson,

2017). Most importantly though, through the use of visuals as a support tool, students must show a deep understanding of the content as they need to critically analyze the concepts to be able to formulate visual representations of the information (Matrix & Hodson, 2017), continuing to facilitate their twenty-first century or transferable skills.

2.4 Consolidation of Topics

2.4.1 Multiliteracies

A multiliterate individual can be defined as someone who is able to adapt his or her understanding and use of literacy techniques among a range of tools and technologies, while maintaining societal and cultural responsibility, and participating as an active and informed citizen (Anstey & Bull, 2006). Additionally, multiliteracies pedagogies work to facilitate the constructivist or self-directed model of learning (Borsheim, Merrit & Reed, 2008), empowering students to engage in literacy practices in a relevant and exciting way. Shareable media articles today capitalize on the use of not only text, but also visual, digital, and other multimodal formats to communicate with the public (O'Byrne, 2014). A multiliteracies approach (New London Group, 1996; Unsworth, 2001; Cope & Kalantzis, 2009) challenges the constraints of traditional methodologies for teaching literacy, moving away from solely textual approaches. Van Heertum and Share (2006) suggest that today's teachers are engaging in a paradigm shift whereby they are accepting multiple forms of meaning or "dynamic representational resources" (p. 252) that are continually reconstructed by users as part of the process of learning. However, multiliteracies do not simply engage learners in multimodal communication; they also give these literacies meanings in multiple contexts, such as text, images, and film (Jacobs, 2013). When

considering the emergence of digital tools and reading methods, the way in which readers receive information is also changing (Hughes & Tolley, 2010); thus, we need to find meaningful ways to engage students.

According to the New London Group (1996), good multiliteracies-based teaching involves four main components; situated practice, overt instruction, critical framing, and transformed practice. The New London Group (1996) suggests that situated practice refers to the idea of framing student learning in socially and culturally relevant ideas. Overt instruction, on the other hand, is how students develop an explicit metalanguage or discourse for learning. Gee (1991) explained the concept of discourses as the ways in which audiences can develop meaning across texts, including those familiar with the content and those who are new to it. Critical framing inspires meaning to the students' social contexts, and transformed practice is the method of transferring and remixing the metalanguage and learned content (New London Group, 1996; Chandler-Olcott & Mahar, 2003). By employing these four concepts, educators mitigate the issue of culturally irrelevant teaching and pedagogy, as they are able to formulate learning based on individual student needs and social practices.

With this in mind, it is important to enforce and identify the differences between legitimate information and other media that have begun to blur that line through media literacy, digital literacy, and critical literacy education (Buckingham, 2007b; Bloom & Johnston, 2010). According to Masterman (1985), media literacy or media education can be defined as "the knowledge, skill and competencies required in order to use and interpret media" (p. 36). Similarly, digital literacies "comprises a variety of cognitive skills that are utilized in executing tasks in digital environments, such as surfing the Web, deciphering

user interfaces, working with databases, and chatting in chat rooms” (Eshet-Alkali & Amichai-Hamburger, 2004, p. 421). Finally, critical literacy concerns itself with “teaching learners to understand and manage the relationship between language and power” (Janks, 2000, p. 176). With these three literacy models in mind, educators need to find a way to bridge these ideas and teach more holistically to the technology-driven student.

Additionally, students are constantly developing new ways to interact with and leverage online multimedia spaces (Alvermann, 2008; Moje, et al, 2008; Jocius, 2013) both in and outside of the school-learning environment, so, teachers in today’s classrooms need to be able to create authentic learning tasks that encourage meaningful interactions with technology (Sadik, 2008), while also teaching students how to appropriately navigate the growing online learning environment (Jenkins, et al., 2009; Bloom & Johnston, 2010) in a safe and education-driven way.

Technology has played a pivotal role in redefining teachers’ approaches to literacy teaching and learning. Digital literacies and the acceptance of multiliteracies is becoming embedded into teaching and learning in the classroom (Labbo & Place, 2010; Cooper, Lockyer & Brown, 2013), with an emphasis on creating or producing with technologies, not simply passive consumption from them. By creating alternative curricular programming that emphasizes the multi- in multiliteracies, educators set the students up for supporting the fluidity of the way in which literacy is taught and conceptualized (Jacobs, 2013). With regards to teacher candidate education, the modeling of these pedagogical practices better encourages their adoption in their future classroom. Pre-service teachers are able to engage with this type of learning during their teacher education programs, which gives them a realistic idea of what is required for this type of learning and understanding

(Borsheim, Merritt & Reed, 2008). Literacy has the capacity to bring students to a more holistic understanding of the world they live in, so by encouraging teacher candidates to explore multiliteracies as a pedagogy to implement rather than solely traditional reading or writing, we are better preparing them for their future practice.

2.4.2 Twenty-First Century Competencies

The twenty-first century brought several changes to the way that educators look at pedagogy, especially with the constant evolution of technology. In light of these more technologically centered perspectives on learning, the notion that students are being adequately prepared for the twenty-first century workforce, with appropriate competencies came into question. Traditionally, these skill sets, such as critical thinking, multimodal communication, collaboration, and creativity, have been looked at in education as soft skills to develop alongside the curriculum, not as their own entity for learning and understanding. Since we are well into the twenty-first century already, this phrase has become dated, so educators are moving towards using the terms such as transferable skills for learning. However, the literature up-to-date on this topic uses the term twenty-first century skills, so for the purposes of this thesis, they will be referred to as twenty-first century skills as well. The Ontario Ministry of Education (2017) define these twenty-first century transferrable skills through the global competencies framework, which uses the categories illustrated in Figure 3.



Figure 3: Framework for global competencies (Ontario Ministry of Education, 2017)

Through these global competencies and technology integration, students are able to make deeper and more meaningful connections with their lived experiences outside of the classroom to the curricular content being taught in the classroom (Cramer, 2007; Binkley, et al., 2012). The competencies identified in Figure 2 extend beyond those traditionally recognized as soft skills, in that they are industry relevant and include ways of interacting, like through methods of communicating and understanding alternative perspectives, with the wider community and world (Jenkins, Clinton, Purushotma, Robison & Weigel, 2009; Silva, 2009; Partnership for 21st Century Skills, 2011; National Research Council of the National Academics, 2012). The overarching concept then lies in what students do with the knowledge they are constructing, as opposed to being able to quantify and assess what units they can retain (Silva, 2009).

Twenty-first century competencies seem to stem from the ideas proposed by educational theorists who inspired the constructivist movement. This included, but was not

limited to, John Dewey and Lev Vygotsky. Dewey (1938) believed that the foundation of education should be experience rather than just theory (Larson & Northern Miller, 2011; Ültanir, 2012), so by building on lived and learned experiences, students should be able to develop a deeper grasp of the concepts being presented to them. In his 1938 book *Experience and Education*, when speaking about the purpose of schooling, Dewey claims, “in order to accomplish its ends both for the individual learner and for society must be based on experience” (p. 39). Dewey emphasized that students should be able to use their interests as a starting point for their learning as long as there was a purpose to the investigation or learning (Dewey 1938; Mills, 2010). Through interest-driven projects, students identify a purpose for study related to their area of interest and pursue study to support a curricular end goal. Though he lived before the major shifts in technology and learning, Dewey’s framework helped to develop problem-based and constructivist learning that is a big proponent of twenty-first century thinking. Vygotsky on the other hand, believed heavily in the social context as a driver of knowledge building (Liu & Chen, 2010; Schreiber & Valle, 2013), especially through his zones of proximal development (Vygotsky, 1978). Vygotsky (1978) spoke to the idea that student learning does have a correlation with their current psychological development, and by teaching with these zones of proximal development in mind; educators would be able to engage in effective teaching. He stated that, “learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers” (Vygotsky, 1978, p.90). Educators should thus be pushing students just outside of their comfort zones in order to encourage knowledge growth and discovery through collaboration with content experts as well as important articles or

products for learning (Mills, 2010). Drawing on the learning theory of Vygotsky, students are encouraged to collaborate and participate in cooperative critical thinking tasks, which may better prepare them for the needs of the twenty-first century workforce.

2.4.3 Multimodality in Digital Literacies Education

There is evidence to suggest that reading and writing skills when connected with other representational systems help individuals create meaning (Gee, 1996; Kress, 2003; Buckingham, 2007b; Mills, 2010; Jocius, 2013). However, the concept of multimodality is not new in education. The blending of modes such as text, images, hypermedia, sounds, and gestures, has impacted the way in which we communicate, both in the physical and virtual worlds (Mills, 2010; Walsh, 2010). Teachers have been using teaching tools like picture books, which combine textual and visual elements in a way that is a meaningful hybrid between the two, whereas students are constantly inundated with multimodal media while perusing their social networking sites or exploring the Web. The use of multimodality enables students to connect with a wider audience through the use of different meaning making devices, and this layering of experiences encourages a deeper connection to the content to be established (Williams, 2014).

Conversely, the success of multimodality is not just in the acquisition of knowledge by the audience; it is also about engaging in the creation of multimodal projects. Multimodality, whether digital or tangible, encourages imagination, critical thinking, problem solving, and creativity (Albers & Harste, 2007). By participating in multimodal creation, students are required to meaningfully select different modalities to purposefully convey meaning about a topic (Walsh, 2010; Jocius, 2013; Barton & Baguley, 2014). This is not to say that traditional reading and writing practices are no longer necessary; it is

simply no longer the only option for communicating in the ever-evolving web-based landscape. Online activities require different modalities or types of digital skills, ranging from scanning text, designing of page displays, and hypermedia literacy but they also often require students to be able to complete tasks in video editing, sound creation, or image manipulation (Godwin-Jones, 2015). Student engagement in these tools is often driven by interest and exploration, but with a shift in perspective, these skills can be leveraged for classroom use.

2.4.4 Infographics as a Tool for Communication

Like many visual tools, infographics offer creators the opportunity to present information in a way that relies on both visual imagery and textual representation, but also requires audiences to both interpret and decode what is being presented to them (Avgerinou & Pettersson, 2011). Tufte (1983, 1990, 1997) and Wurman (1989), through their work in the field of graphic design, offered effective use of design principles for information design and problem solving that can be applied to this type of learning and communication. It has been shown that images are often more impactful when trying to persuade an audience when compared to text alone (Trumbo, 1999; Griffin, 2008; Green & Myers, 2010; Lazard & Atkinson, 2015), so by empowering students to engage in multimodal artifact creation, we are fostering a wider set of literacies skills. Additionally, the use of imagery and iconography encourages a more holistic and emotional response from an audience. Creators of visual media often bank on the fact that it will elicit some familiarity between the audience and the article (Avgerinou & Pettersson, 2011) and will also that may encourage memory storage (Reavy, 2003) making the final product more effective as a communication tool.

However, while infographics are widely shared online through social networking sites like Twitter, LinkedIn, and Facebook (Toth, 2013; Albers, 2014; Lazard & Atkinson, 2015), they are often not created with much content focus. Rather, the importance in most of these infographics is the ability to go viral and the overall visual appeal (Albers, 2014). Often they are visually pleasing with a plethora of clip art, fonts, and colours, but they lack the information density that will actually educate a reader on a specific area of interest (Albers, 2014; Arslan & Toy, 2015). Infographics should be designed with a strategy and audience in mind, thus pushing the creation of the artifact to produce an effective educational experience for the reader without seeking out additional resources (Toth, 2013; Arslan & Toy, 2015). By creating and sharing infographics, students will be able to foster these communication and design skills, which will potentially become very important in their future workplace and educational endeavours.

2.5 Limitations and Gaps in Previous Research

A major limitation is that current literature does not really acknowledge the use of infographics as a communication tool in the traditional kindergarten to grade twelve learning environment. While it has begun to be adopted in other industries, like the business, journalism, and medical sectors, the uptake of this tool is still under investigated in the field of education. While some research has been conducted, it mostly focusing on the implications in higher education studies (Vanichvasin, 2013; Matrix & Hodson, 2014; Sudakov, Bellsky, Usenyuk & Polyakova, 2014; Mendenhall & Summers, 2015; Lyra, et al., 2016; Ozdamli, et al., 2016), so the gap exists in the study as it relates to K-12 education and curriculum. At the time of the completion of this thesis, only two articles could be

found that were written about work within the kindergarten to grade-twelve system (Krauss, 2012; Kos & Sims, 2014). In Krauss' article, *Infographics: More than words can say*, she advocates for the use of infographics as a communication tool. The article continues to outline her five steps to create an effective infographic as well as some project examples that she would use within the classroom (2012). Krauss does not actually share any findings as this was created as more of a resource for teachers rather than an academic study. So, while this is a helpful tool for teachers, it does little to lessen the gap that exists in academic research on this topic. Kos & Sims (2014) on the other hand focused their study on middle school students in Colorado. They implemented a STEM-Careers Infographic Project (SCIP) with 180 grade eight students over a four-week period. During this intervention, students chose a STEM career path and researched about it in order to create an infographic about the career and presented it to the class. The researchers would provide questions or prompts for students during the research phase if they felt it necessary. Kos & Sims explored the similarities of infographics and essays and outlined them through a graphic that was shared with students (see Figure 4). The researchers found that infographics offered a diverse way of presenting data and information in a way that was deemed

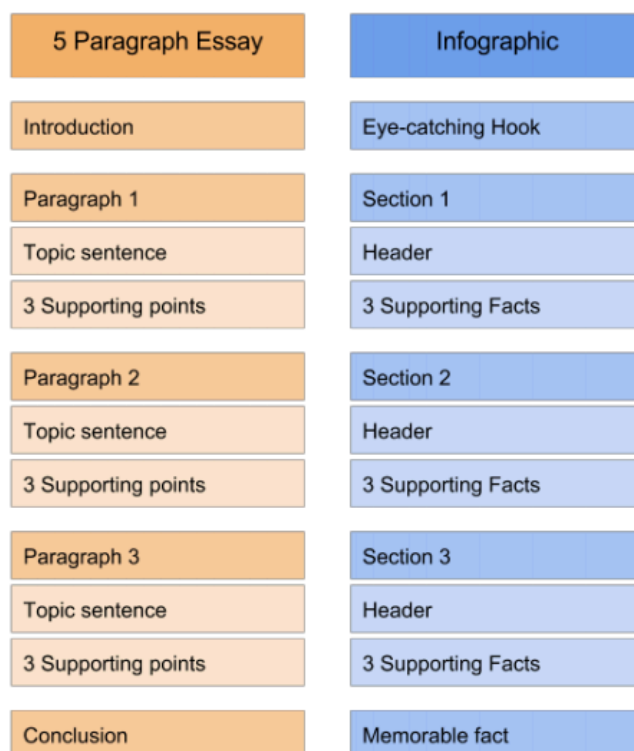


Figure 4: 5-Paragraph essay structure vs. infographic structure
(Kos & Sims, 2014)

preferable to the students in the study. Additionally, students identified as being more engaged and enjoying the creation process more with an infographic when compared to a traditional essay assignment.

The existing research propagates the potential efficacy of this communication tool in the web 2.0 universe, but the actual applicability and curricular connections have yet to be explored. This research project aims to begin to reduce the gap that exists in this research area and encourage students to utilize a more multiliterate and multimodal approach to their learning experiences.

2.6 Research Questions

This study investigated the following four questions:

- 1) What affordances and constraints exist for teacher candidates who engage in the consumption and production of infographics?
- 2) How does the reading and writing of infographics help teacher candidates develop their digital literacies skills?
- 3) How does the creation of infographics intersect with the development of twenty-first century competencies, such as multimodal communication, creative and critical thinking, collaboration, problems solving and cultural and global citizenship?
- 4) In what ways do teacher candidates envision using infographics in their own teaching?

3 Method

3.1 Design

This study employed a pragmatic approach to mixed methods research utilizing qualitative case study techniques (Stake, 2000) along with quantitative methodologies. In order to be selected for the in-depth case study, the participants had to be currently enrolled in the Bachelor of Education program at a specific University in Southern Ontario and complete all phases of the research study. According to Creswell (2014), pragmatic research employs both qualitative and quantitative practices to provide a more holistic view and understanding of the data and research questions. This research philosophy emphasizes the importance of identifying a real world problem and finding a plausible and practical solution to said issue (Creswell, 2014). The problem in this research study was whether or not an alternative communication method, infographics, could be used as an effective learning tool for teacher candidates enrolled in an initial teacher education program. Through mixed methods research, the researcher was able to formulate findings that would not have been found by using either quantitative or qualitative research independently (Creswell, 2014). Additionally, the mixed methods, multi-phase, case study approach enabled the researcher to work more closely and collaboratively with the participants, empowering them to share their viewpoints and ideas, providing richer data through multiple perspectives (Crabtree & Miller, 1999; Baxter & Jack, 2008).

In terms of quantitative data, a pre-research questionnaire was administered online containing eight Likert-style questions to assess the participant's knowledge of the research content, including digital literacies, technology use, infographics, and literacy

education, to establish a baseline for participants' understanding. Participant demographic data was also collected at this time. In addition to the Likert-style questions, participants also completed a series of open-ended qualitative questions where they expanded upon ideas underlying the research questions (Appendix B). These qualitative responses would act as a guideline for the one-on-one interviews that would follow in phase two, and would also be used in the final concluding interview at the end of the project (phase four).

Following phase one, the participants were invited to complete a pre-study interview (phase two) to provide additional qualitative data that would either support or contradict the information provided through their questionnaire responses. The answers were compared to those received from the online questionnaire for similarities as well as disparities. These were used in the formulation of the questions for the phase four concluding interviews.

Next, the teacher candidates entered the participatory phase of the research. Here they were asked to use an online freeware to create an infographic on the topic of their choosing. They could include, as much or as little information as they felt was appropriate, to support their topic and provide the audience with a thorough enough understanding of the subject matter.

Finally, participants were asked to complete a final one-on-one interview with the researcher along with an online questionnaire. The interview focused on how the opinion of the participant evolved over the course of the study, as well as touching on the infographic that they created during the third phase. Teacher candidates were asked about responses they gave during phase one and two and how those responses supported or

challenged the infographic they created in phase three. There was audio and video recording of these phase four interviews, which were transcribed for later analysis purposes. The answers provided in the final questionnaire were compared to those given in the pre-research questionnaire to assess for growth and perspective shifts.

3.2 Participants

The study took place primarily in a university in Southern Ontario, Canada, and also partially in an online individual environment. The online environment included Google forms for the pre- and post-research questionnaires and Piktochart (Piktochart, 2018) for the infographic creation during phase three. There were a total of nine teacher candidates that volunteered as participants for this study, five males and four females, ranging from 23 to 40 years of age. During the course of involvement in the study, each participant was enrolled in his or her initial teacher education program in either the Primary/Junior (n=5) or Intermediate/Senior (n=4) division. Primary/Junior refers to teaching kindergarten through grade six, whereas Intermediate/Senior concentrates on grades seven through twelve. Of the nine participants, four were enrolled in the concurrent education program and the other five were a part of the consecutive education stream. The backgrounds of the Intermediate/Senior participants varied across subjects, with three coming from science undergraduate degrees and one from a humanities undergraduate program.

Of the nine students, four of participants were selected for a more in-depth case study analysis, all of which happened to be males. These teacher candidates were the only four to complete all of the phase-related tasks, so they offered the most complete picture of the impact of the study. The participants entered the study with a variety of technological

skills, none of which who identified as having complete expertise in their infographic creation abilities, though they were familiar with the medium. These teacher candidates were given researcher-selected pseudonyms: Phillip, Luke, Eric, and Jake. To account for time constraints on behalf of the teacher candidates' schedules, the researcher opted to assign pseudonyms rather than ask the participants to select them. The following table (Table 1) offers insight to the background of the participants who were selected as the cases to be studied.

Table 1. Case Study Participant Background Data

Participant Name	Undergraduate Degree	Age	Teacher Education Stream	Program Division
Phillip	Bachelor of Arts	40	Consecutive Education	Primary/Junior
Luke	Bachelor of Arts (Honours)	23	Consecutive Education	Primary/Junior
Eric	Bachelor of Sciences (Honours)	23	Consecutive Education	Primary/Junior
Jake	Bachelor of Sciences (Honours)	23	Concurrent Education	Intermediate/Senior

3.3 Context

The study was primarily conducted in an educational research laboratory setting in Southern Ontario. Teacher candidates completed the online tasks on their own technological devices, all of which were either MacBook or PC laptops. Teacher candidates were asked to meet the primary investigator on two separate occasions at the laboratory location to conduct one-on-one interviews or complete phase related tasks. Each in-person

meeting was arranged to be 30-minutes or less to account for the fact that the teacher candidates were still completing the requirements of their Bachelor of Education degrees and had to work around their class schedules and assignments. The online portions of the research included Google Forms pre- and post-research questionnaires and Piktochart (Piktochart, 2018). These components were completed on their own time at a location of their choosing, in accordance with their coursework and practicum schedules, and were submitted to the primary investigator through email. Participants were also able to contact the researcher through email communication with any questions or concerns throughout the duration of the study.

3.4 Procedure

Prior to beginning this study, the primary investigator submitted an application for research study to the University of Ontario Institute of Technology (UOIT) Research Ethics Board (REB) and approval was granted on February 2, 2017, REB#14131 (Appendix J). Due to the time constraints of the teacher candidates as they completed their Bachelor of Education degrees, the application was resubmitted for renewal, which was approved on January 10, 2018 (Appendix K). Additionally, as a requirement of Tri-Council research, the researcher completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics, which was granted on April 8, 2016 (Appendix L). With all of these pre-research steps completed, I reached out to the Faculty of Education student body for participant volunteers.

3.4.1 Consent

The researcher attended a cohort-wide lecture and presented the research study opportunity to the entire teacher candidate population. At this time the phases and requirements were explained to the teacher candidates and those who were interested in participating in the study were asked to stay behind to chat with the researcher or reach out via email communication.

Nine students reached out to the researcher and they were given consent forms to read and review. The consent forms provided a detailed outline of the study and advised the participants of their rights and advised the teacher candidates that they had the ability to withdraw from the study at any time, regardless of what phase they were at, without any penalty. The potential participants were invited to ask any questions that they had about the research project or consent document prior to signing anything. The researcher received informed consent from each teacher candidate who was willing to participate in the research study (Appendix A). All of the signed consent forms were collected and kept in a sealed envelope until the commencement of data analysis.

3.4.2 Data Collection

Data collection followed the steps outlined below (Table 2). Due to the requirements of the teacher candidates for the Bachelor of Education program, the timeline worked with their schedule and took place over a four-and-a-half-month period.

Table 2. Data Collection Procedures

Step	Procedure	Time
1	Teacher Candidates receive, fill out, and submit consent forms	Prior to Study

2	Teacher Candidates complete pre-survey questionnaire	Prior to Study
3	Researcher to review results of the questionnaires	Prior to Study
4	One-on-one interviews with Teacher Candidates & Sorting Activity	Week 1 & 2
5	Review and transcribe audio/video from interviews	Week 3 & 4
6	Teacher Candidates to create their personal infographics	Week 5 - 10
7	Researcher to review the infographics	Week 11 & 12
8	Researcher formulates follow-up questions for the final interviews	Week 13
9	One-on-one final interviews	Week 14 – 17
10	Transcription of the videos	Week 18

3.5 Data Collection

3.5.1 Overview

In order to enhance reliability, validity and to provide a more thorough understanding of the participants' opinions and knowledge, both quantitative and qualitative data were collected and analyzed for the four phases in this research project. Questions asked in the pre-survey aimed to develop a baseline understanding of the research topics prior to beginning the study. This allowed the researcher to compare participants' prior understandings with their learning as they progressed through the research study. The researcher was able to interpret the variety of qualitative data from the

open-ended pre-survey responses, transcribed and video data from the phase two and four videos, as well as derive meaning from the teacher candidate created infographics. The qualitative validity of this study was reinforced through the multiple activities completed by the participants and the diversity of data collected from these phases.

3.5.2 Phase One: Pre-Survey Questionnaire

Quantitative data were collected through an online pre-survey questionnaire composed of eight Likert-style questions as well as ten open-ended responses (Appendix B). The pre-survey was used primarily to establish a baseline of understanding of the teacher candidates for the content of the research study. The Likert-style questions concentrated on the teacher candidates comfort levels surrounding use of technology in the classroom, preconceptions of literacy education, as well as their opinions on infographics in education. The open-ended questions focused on the participants understanding of digital literacies education, twenty-first century competencies, and infographics as an educational tool. The open-ended questions encouraged the teacher candidates to offer additional insight into their responses that would provide a more holistic understanding when it came to later data analysis. The Likert-style rating scale was employed in collaboration with the open-ended questions because it is a way to rate teacher candidate outlooks, observations, and beliefs about the topics in a reliable and valid way (Cohen & Manion, 2000).

3.5.3 Phase Two: One-on-one Interview & Task

Following the completion of the pre-survey questionnaire, the teacher candidates were asked to come to the educational research laboratory to complete both an infographic sorting task in the style of a one-on-one interview with the primary investigator. Each

participant was provided with the same set of three infographic printouts (Figure 5, 6 & 7, for clearer images see Appendix D) and was asked a series of questions pertaining to those infographics (Appendix C & E).

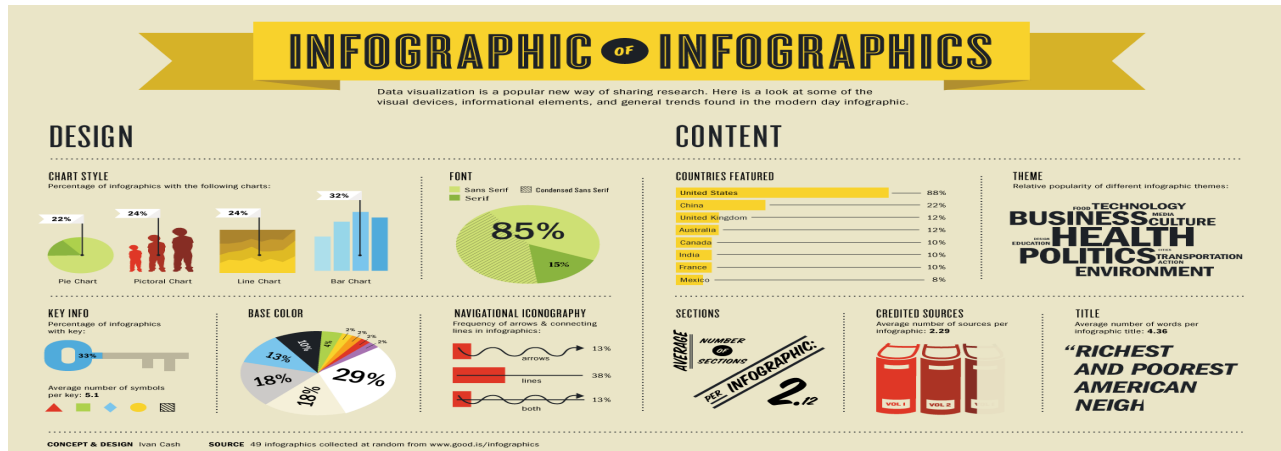


Figure 5. Sorting task infographic A



Figure 6. Sorting task infographic B

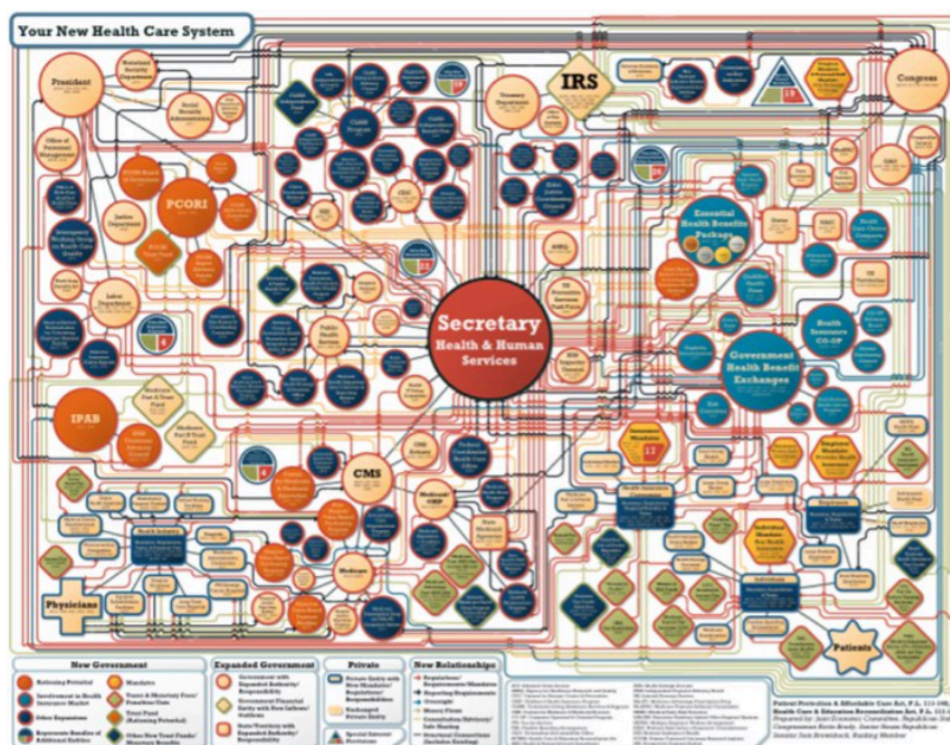


Figure 7. Sorting task infographic C

The infographics were labeled A, B, and C, for the purpose of identification during data analysis. These three infographics were selected because the researcher felt that they would illicit emotional responses and able to be dissected by participants. Infographics A and B (Figures 5 & 6) were both good examples of infographics, so the researcher hypothesized that the teacher candidates would resonate with one of those, findings both positive attributes and potential areas for improvement. Infographic C (Figure 7) was selected as an example of what to avoid when creating an infographic. This infographic was meant to illicit a strong negative response and allows the teacher candidates to outline what specifically they do not like about it and offer ways that they believe it could be improved. With these three infographics selected, the researcher was interested to see if and how the teacher candidates would take their constructive feedback for the infographics

provided, and apply it to the ones that they would create in phase three. Each interview and sorting task took thirty minutes or less for the participants to complete. The goal of this task was to gauge the teacher candidates' current levels of understanding as they pertained to infographics that had already been created for them. Key themes were triangulated for cross-case comparison. This informed the researcher in the creation of the Infographic Matrix (Figure 9) used later in the study. These interviews and the sorting task were audio and video recorded for data collection and analysis purposes. The audio was transcribed by the researcher and used in the data analysis.

3.5.4 Phase Three: Teacher Candidate Created Infographic Artifact

For the third phase of the research project, the teacher candidates were given the opportunity to explore an issue that they were passionate about and create an infographic to teach an audience about that topic (Appendix F). They were asked to use the online freeware Piktochart (Piktochart, 2018) as the infographic design tool, but were given the option of seeking out another software if they had something that they preferred. The teacher candidates were given no specific guidelines on how they were to create their artifact, only that they needed to stick to their topic of choice and explain it to a non-industry related audience. These were submitted electronically as PDF documents to the researcher via email communication. Since the participants had to balance the completion of this task with their coursework, the researcher gave the teacher candidates one month to complete this phase.

3.5.5 Phase Four: Post-Research Interview & Questionnaire

The final research phase involved the researcher analyzing the infographics that were created by each of the participants. The researcher utilized an Infographic Matrix (Figure 7) that was created for the purpose of infographic assessment. This matrix was adapted from the work of Kafai and Peppler (2011) and their DIY-Production Framework. Once they were assessed, the participants were invited to complete a one-on-one post-research interview with the primary investigator. At this time they were asked a series of questions pertaining to the study at large. These were more general questions and they were asked to all participants. Following the general questions, there were some created for each individual participant based on the infographic that they submitted during phase three. Both sets of questions can be found in Appendix G. In the latter half of the interview, participants were asked about comments or information that they provided during the phase two interviews and how that was supported or different from what they produced for the infographic task in phase three. Finally, the participants completed an online post-research questionnaire that followed up with the questions asked in the pre-survey questionnaire.

3.6 Data Analysis

3.6.1 Questionnaire Responses

The pre-research questionnaire employed both quantitative and qualitative data collection techniques. The quantitative research methods were focused on Likert-style questions whereas the qualitative questions were more open-ended in their nature. The quantitative data were assessed and a baseline level of understanding was determined for

each of the participants in the study. These results were then compared to the responses given in the surveys during phase two and four, to check for growth or changes in teacher candidate perspectives on infographics in the learning environment. Content analysis (Krippendorff, 1989, 2004; Berg, 2007) was used for the qualitative responses during this phase of the research process. In order to gain a more holistic understanding of the teacher candidate perspectives, the quantitative and qualitative data were then considered together for a final interpretation of the results (Creswell, 2014).

3.6.2 Interview Transcriptions

In order to respond to the research questions, content analysis (Berg, 2007) was used on the interview transcripts from phase two and four. Content analysis is used to focus on the replicable but unobservable data that can be inferred during interviews and through research artifacts like images, printed matter, or sounds (Krippendorff, 1989, 2004), which is sometimes overlooked in traditional quantitative research studies. Responses from the initial interview were compared to those from the concluding interview to determine if the teacher candidates experienced any growth or changes in their opinions on the efficacy of infographic use as a communication tool as well as digital literacy education in the twenty-first century learning environment. Additionally, teacher candidates were questioned about their responses to their pre-survey questionnaire, which provided additional data regarding the efficacy of the proposed use for infographics. According to Krippendorff (1989, 2004), through content analysis, the researcher was able to gain new insights from the patterns that emerged from the perspectives being shared during the individual participant interviews.

3.6.3 Infographic Artifacts

Content analysis (Krippendorff, 1989, 2002; Berg, 2007) and multimodal textual analysis (Hull & Katz, 2006; Jewitt, 2008) were utilized for this section of the research. According to Jewitt (2008), “multimodal analysis offers a way to broaden the lens of educational research and investigate the role of image and non-linguistic modes” (p. 258). For the purpose of this study, the emphasis of non-textual methodologies in tandem with linguistic communication influenced the decision to employ this type of analysis for the teacher candidate created artifacts. By examining the infographics from a multimodal lens, the power of the images, graphics, and artistic choices, became more important in the overall understanding and consumption of the artifact. In order to assess the text component of the infographics, content analysis (Krippendorff, 1989, 2004; Berg, 2007) was used as well. When considering how and why the teacher candidates made the decisions they did with regards to language, the overall efficacy of the infographic became clearer. Through content analysis (Krippendorff, 1989, 2004; Berg, 2007), the infographics were assessed for specific themes or codes. With these codes, the researcher was able to better compare the teacher candidates across cases.

To support the multimodal textual analysis, the researcher, with the guidance of Dr. Hughes, created an infographic matrix, adapted from the work of Kafai and Peppler (2011). Kafai & Peppler (2011) used the participatory competencies with regards to do-it-yourself (DIY) production in their framework, which include the technical, critical, creative, and ethical practices of production. The full overview of their framework of participatory competencies can be seen in Figure 8.

Participatory Competencies	Practices	Definitions
Technical practices of production	Coding	Practice of computer programming, particularly the use of loops, conditional statements, parallel execution, object-oriented programming, sequencing, synchronization, time triggering, real-time interaction, Boolean logic, variables, event handling, user-interface design, statements, and numerical representations (Malan, 2007; Maloney, Peppler, Kafai, Resnick, & Rusk, 2008)
	Debugging	Practice of persisting when confronted with technical problems either prior to or during production (National Research Council, 1999)
	Repurposing	Practice of reusing earlier ideas or chunks of materials to build on in a single work or in multiple works (National Research Council, 1999). This is also a common practice particularly in the professional computer programming community
Critical practices of production	Observing and deconstructing media	Careful observation by youth looking more closely than ordinarily at everyday objects (Hetland, Winner, Veenema, & Sheridan, 2007) and deconstructing both the parts of the text (at a literal level) and the meaning behind the text
	Evaluating and reflecting (i.e., critique)	Practice of peers negotiating what constitutes a “good” project (Peppler, Warschauer, & Diazgranados, 2010; Soep, 2005). Asking one another (even informally), given a particular artistic goal, how successfully has this goal been met?

(continued)

Participatory Competencies	Practices	Definitions
Creative practices of production	Referencing, reworking, and remixing	Practice of creating original works that make knowing reference to previous works (such as games, cartoons, music, etc.). Wholly original work produced as art falls into the category of playable art and is excluded from this category (see Mitchell & Clarke, 2003). The modification of existing games, images, or sounds, often to create new interactive pieces or “machinima” or noninteractive movies. Also the act of creating new genres, combining genres, or taking something from one genre and making it into something else (see Erstad, Gilye, & de Lange, 2007)
	Making artistic choices	Practice of learning about, appreciating, and applying artistic principles (similar to Gee, 2003), including choosing objects as well as their colors, size, movement, and on-screen positioning. This is further defined as working within a single modality to augment meaning
	Connecting multimodal sign systems	Practice of learning about, appreciating, and designing interrelations within and across multiple sign systems (images, word, and action; Gee, 2003; Jewitt & Kress, 2003; Kress & van Leeuwen, 2001). This is further defined as working across two or more modalities to augment meaning
Ethical practices of production	Crediting ownership	Practice of referencing intellectual origins of “text” in use of media production (Perkel, 2008)
	Providing inside information	Practice of judiciously sharing insider codes, shortcuts, and solutions according to the cultural values in the community (Fields & Kafai, 2010)

Figure 8. DIY production matrix (Kafai & Peppler, 2011)

The matrix created by Kafai and Peppler (2011) did not address the needs of teachers who wanted to use infographics specifically in their classrooms, which prompted the researcher to create a matrix exclusive to infographic creation (Figure 9). The researcher-created matrix followed the lead of Kafai and Peppler (2011), using participatory competencies as a way to organize the information. This new matrix focused on three practices that the researcher felt were particularly applicable when considering infographic creation: design, utility, and ethics. The details and rationale are outlined in Figure 9.

Competency	Practices	Definitions
Design	Layout	Western languages read top to bottom and left to right, this should be considered when the infographic is designed (Lankow, Ritchie & Crooks, 2012). Additionally, considerations should be made whether the graphic is created in portrait or layout position.
	Hierarchy of Information	The information in the infographic should read from most important to least important, or in a way that emphasizes the importance of specific content. This can be done through use of text or other modes of communication (visuals, audio, graphs, etc.).
	Aesthetics	Basic design principles should be considered as they create a more appealing product. Font, colour, text size, use of white space, line, and value should be considered.
	Use of Graphics and Icons	The visuals used should engage the readers and not act as a distraction from the purpose of the infographic (Bateman, Mandryk, Gutwin, Genest, McDine & Brooks, 2010). The graphics should be clearly relevant and represent the information appropriately. Icons and graphics should be universally understood (i.e. a check mark to mean yes or correct).
Utility	Efficacy	The infographic should be made in a way that communicates a specific objective or purpose (Lankow, Ritchie & Crooks, 2012). Additionally, it should generate content using small chunks of text with the support of images/graphics (Clark & Mayer, 2011).
	Communicative Approach	The infographic should utilize either a narrative or explorative communication approach (Lankow, Ritchie & Crooks, 2012). The information provided should reflect the choice of approach for the infographic.
	Point of View	The purpose and topic are clearly presented and consistent

		throughout the infographic. The viewer should be able to find the main points of the infographic easily. The reader should be able to identify the objective of the infographic easily.
	Entertainment Value	Use graphics/images that support the text and that do not distract from the overall message (Clark & Mayer, 2011). Cognitive load should be considered to maintain the purpose of the infographic while making it interesting and engaging for the reader.
	Audience	The infographic was created with an intended audience in mind, which is reflected in the creation.
Ethics	References	Information should be cited appropriately to credit the origin of the "text."
	Accuracy of Information	Information should be presented in a way that is not misleading or a misrepresentation from its original purpose. Infographic should be error free.

Figure 9. Infographic production matrix

While completing the data analysis on the infographics created by the teacher candidates, the researcher compared each of the individual infographics to the matrix (Figure 9). Comments and questions were written for each infographic, and these were used in the formation of the individualized questions for the phase four one-on-one interviews at the conclusion of the research. Results were compared across participants to see where there were similarities and differences in their performance and success with the creation of their infographic artifacts.

3.7 Chapter Summary

In summary, to best address the questions guiding this research, a variety of data collection methods were used in this study. These tools included pre- and post-research questionnaires, structured one-on-one interviews, infographic tasks related to both production and consumption. In addition, observation and transcriptions were used with the intention of allowing participants to express themselves across a variety of modalities. Keeping in line with the literature that drove this research, the effort to exhibit multimodal

teaching throughout this study was a strategic choice by the researcher in order to show the applicability of these tools and methodologies for the teacher candidates in their future classrooms. Through the researcher encouraging multimodal communication from the participants, it was hoped that teacher candidates would provide richer and more all-encompassing data to be analyzed in the next steps of the thesis process.

4 Results

4.1 Overview

This study focused on four main research questions:

- 1) What affordances and constraints exist for teacher candidates who engage in the consumption and production of infographics?
- 2) How does the reading and writing of infographics help teacher candidates develop their digital literacies skills?
- 3) How does the creation of infographics intersect with the development of twenty-first century competencies, such as multimodal communication, creative and critical thinking, collaboration, problems solving and cultural and global citizenship?
- 4) In what ways do teacher candidates envision using infographics in their own teaching?

The participant population began with a sample of nine teacher candidates (five male and four female) from a Southern Ontario Bachelor of Education program. Four of the participants were selected for case study analysis for participation in this research project. In-depth case study research was utilized to stretch beyond the limitations of statistics and quantitative measures, and delve deeper into the conditions through the participants' perspective. By narrowing the field down to four cases, the researcher is better able to triangulate for specific themes and compare them across participants for a more holistic

understanding of the issues being studied. Only four participants fully completed all four phases of the study, so their work and responses were investigated throughout this thesis. The results of data collection will be discussed with regards to each individual participant and will be shared through their personal case studies as they progressed through the four research phases.

4.2 Phase One: Pre-Research Questionnaire

The pre-research questionnaire was made up of a combination of quantitative Likert-style questions as well as several qualitative open-ended questions. For the Likert-style questions, participants provided responses to questions about technology use and their understanding of literacy education on a scale from one to seven, one being not-at-all, and seven meaning very much so. The open-ended questions provided more in-depth responses for the researcher to better understand their viewpoints. All questions can be found in Appendix B. This phase of the study was completed by all of the initial participant volunteers. Though each participant came into the study with a different academic background and experiences, they all identified as comfortable with using digital technologies in their classrooms, with 33.3% of respondents classifying themselves as incredibly confident in the pre-research questionnaire.

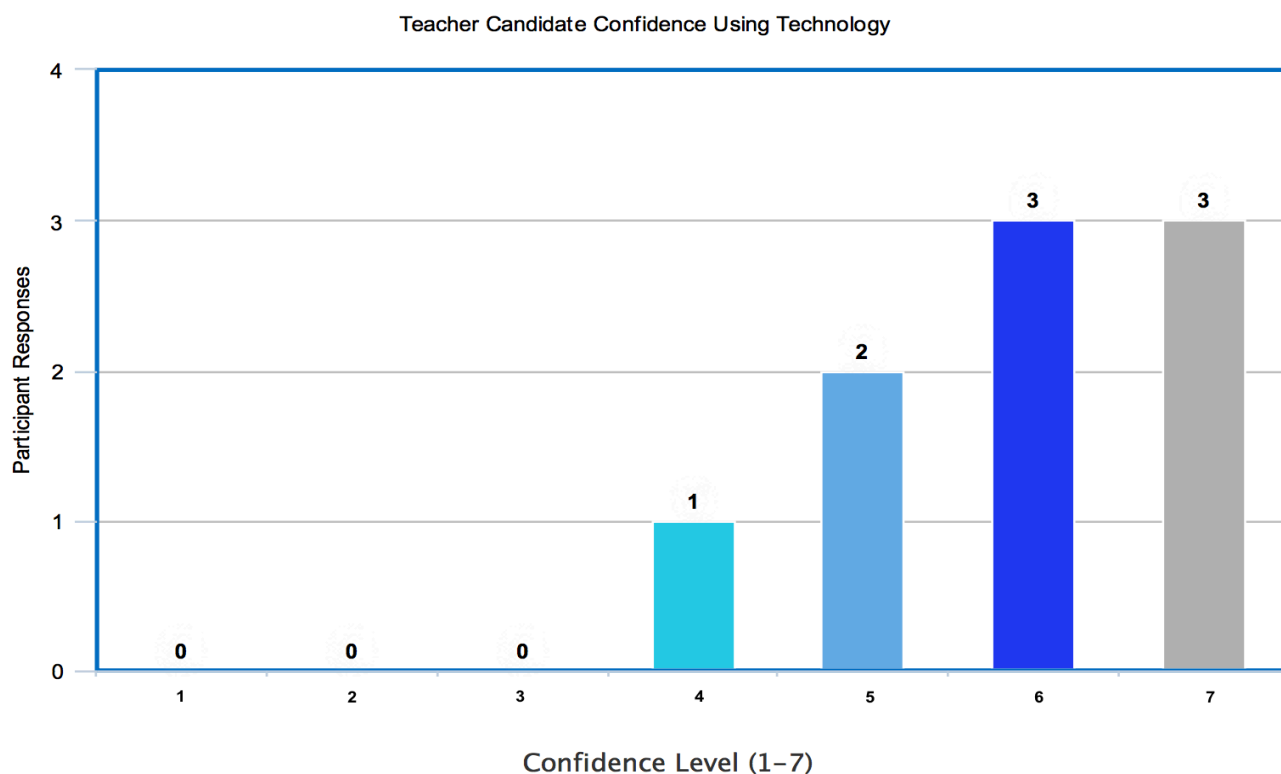


Figure 10. Confidence levels using technology in teaching

However strong the participants felt that they were with respect to digital technologies, they did not all identify the same confidence with infographic production. Twenty-two percent of participants claimed to be only moderately confident in their ability to communicate through an infographic. Additionally, all nine participants responded that they had some previous experience using infographics in their learning journey, mostly acknowledging that they were completed in the form of an assignment during their Bachelor of Education coursework. Only two participants of the nine mentioned using infographics in their practicum teaching experiences prior to the beginning of the study. When asked whether or not they felt students enjoyed being taught literacy through more traditional methods, the answers varied between participants (Figure 11) with most responses coming in around the neutral zone (3-5).

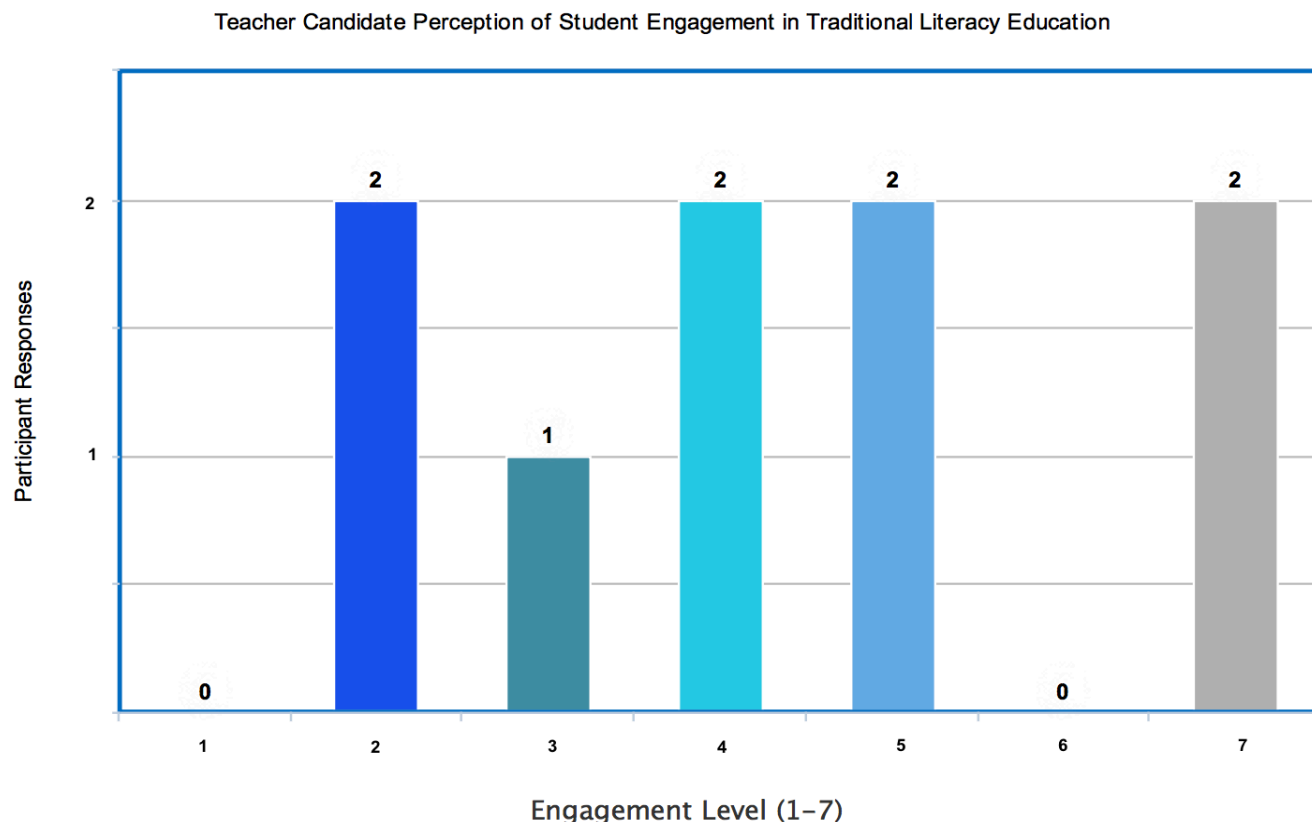


Figure 11. Student engagement in traditional literacy education

Regardless of the fact that the literature has shown that traditional, text-based literacy education and assessments may not be effective for all students (Buckingham, 2007a; Philip & Garcia, 2013; Fullan & Langworthy, 2014; Henthorn & Cammack, 2017), the teacher candidate pre-survey responses showed that they remained unsure of whether or not students enjoyed those methodologies. The teacher candidates seemed reluctant to rely on their personal experiences with this type of teaching and preferred to fall back to what pedagogies and practices were used on them when they were students in the K-12 system.

4.2.1 Phillip

Phillip came into the research study with a background in the field of business, with his shift into teaching being his second career. His studies focused on the Primary/Junior

divisions of education. He acknowledged that sharing information in a digital format was something that he was comfortable with and a skill that he had relied on during his initial career in business. With this background, Phillip was clear in his support for the use of this type of communication tool in the classroom as he felt it aligned with many of the skills he saw in the workplace that he would be educating students to move towards. Most importantly, in the pre-research questionnaire he felt that infographics offered teachers the opportunity to reach a wider range of students due to the multimodal nature of the tool it would appeal to more learning styles and preferences than text based communication. With regards to his own understanding, Phillip found infographics to be an appealing communication medium because they are “easier to read and understand” than more traditional handouts or presentations. He ranked himself as confident with regards to his understanding of digital literacies and infographics as a tool for his communication.

4.2.2 Luke

Luke came into the study as a Bachelor of Education candidate fresh out of his undergraduate studies. He was a member of the consecutive education program with a focus on Primary/Junior education. Luke commented that digital literacies and twenty-first century skills should not be taught in the same fashion as curricular content; rather they should be fostered throughout a student’s educational journey. He felt that educators should consider digital literacies and twenty-first century competencies as more than just an add-on to learning; they should be fundamental and constantly underlined in the classroom. Luke identified as having used infographics for several purposes, both within and outside of the learning environment. Prior to beginning this study, Luke was already

utilizing infographics in his practicum placements with students as young as grade one. He mentioned that his students created infographics in their science class to “highlight the functions of selected organs in the human body.”

When asked to define digital literacies, Luke mentioned the importance of exercising twenty-first century competencies, and that it was crucial as a new educator to remain current in technology integration as well as to be able to relay information efficiently and effectively to both students and colleagues. Luke emphasized that infographics encourage students to communicate using pictures, symbols, and words, which was a skill that is useful for students or learners at any grade level, including those engaging in professional development.

4.2.3 Eric

Like Luke, Eric was accepted to the Bachelor of Education program right after completing his undergraduate studies. He was part of the consecutive education program with a focus in primary/junior education. Eric identified himself as being proficient with technology, saying in the pre-research questionnaire “others come to me for help when it comes to technical difficulties.” Like his colleagues, he had also used infographics before entering this study, but unlike his peers, he found the task to be challenging from a communication standpoint. He was creating it for a math class, and found that “trying to find a way to be concise but also expansive” made for a very difficult task, especially in mathematics. However, he also acknowledged that his only experience with infographics was as a student and that he had not had the opportunity yet to use them as a teacher. Eric was clear in his opinion that “infographics help in learning about a topic by making the data

easy to extract and interesting to the reader/viewer.” He further expressed that infographics could be an incredibly beneficial learning tool as they can act as a “great stepping stone for others to gain interest and knowledge about a topic,” which is important for teachers in the classroom setting.

4.2.4 Jake

Jake identified himself as a member of the concurrent education program, focusing on Intermediate/Senior education in Biology and Chemistry. Unlike his peers, he did not immediately recognize himself as completely digitally literate. His understanding of the definition of digital literacy meant that an individual must be able to use the information they are finding. It was not enough to simply be able to locate it in the online realm. According to his pre-research questionnaire, he felt that his skill set was highly dependent on the information that he was working with and that it was a definite area of improvement for him as both a learner and an educator. Similar to his colleagues, he had used infographics prior to this research study, but had very limited experience, only having created one himself as a project during his Bachelor of Education studies. When asked in the pre-research questionnaire about the process of creating the infographic, he said, “the first time was more time consuming”; however, he also recognized that with more practice “the process becomes more natural.” This being said, Jake believed that the knowledge he had in digital literacies would offer him a unique perspective to designing and sharing his infographic artifact in the later phases of the research.

4.3 Phase Two: One-on-one Interviews & Infographic Sorting Task

The second phase of the research project focused on allowing the teacher candidates to expand on or clarify some of the responses that they gave during the first phase. This was done following the sorting task. The sorting task required students to rank and assess three infographics provided by the researcher. Initially questions were asked to the participants during the sorting task to help the researcher develop a baseline of understanding for when the teacher candidates moved on to the third phase where they were going to create their own infographic artifact. The responses they gave allowed the researcher to make amendments and adjustments to the matrix that would be used in the analysis of the phase three artifacts. For example, after phase two, the participants mentioned the importance of presenting information in order of importance, like stated in the matrix, but they emphasized that the use of multimodality was key for successful communication. This prompted the researcher to reword the description of the 'hierarchy of information' section of the matrix to reflect the need for more than solely text-based explanations.

The participants were also tasked with an infographic sorting activity, using the infographics found in Appendix D. During this task the teacher candidates were asked to rank the infographics from most effective to least effective and then provide a clear explanation for why they made the decisions they did. These responses were then used during phase three as a point for comparison to the artifacts that they created to see whether or not the participants followed through on improving on the participant

perceived shortcomings of the infographics, if they employed the elements they felt were successful in this phase, or if they disregarded them entirely.

4.3.1 Phillip

During the sorting task, Phillip described his method for ranking the infographics revolved around “ease of reading.” With this in mind he ordered them A being the best, B having some room for improvement, and C being the worst option. Coming from the business sector, he acknowledged his familiarity with spreadsheets, and that when he was presented with an infographic in the landscape format, like infographic A, he felt more comfortable and that it was more effective. He also stated that cultural differences could influence how people read an infographic, whether reading from left to right or top to bottom, so this was something that he would have to consider as he moved into his professional practice. When it came to infographic B, he recognized that the use of bright colours and cartoon graphics stood out and drew him to look at that infographic. He said a downside to this infographic was the background colour. He noted, “the background, being almost peach coloured, and then the coral and pink shades, could be too much for someone who is colour-blind. He felt that this disability was something that may be overlooked and was important to acknowledge and make his students aware of if they were to create infographics or other digital presentations. Finally, he noted that infographic C was simply too busy and overwhelming to look at.

In the phase two interview, Phillip noted that an element of infographic creation that stood out to him was the opportunity for the creator to engage in the design process. He communicated that ease of reading of the final product as well as aesthetic appeal were

critical elements to the overall success of an infographic. Additionally, he felt a key area of infographic success was in the author's ability to keep the overall design as simple as possible. Phillip mentioned that he was really overwhelmed by the clutter that appeared in infographic C. He preferred infographic A because it was "really chunked out, everything is nice and clear and neat, nothing blends in or bleeds into each other... it is very easy to navigate." He alluded to the multimodal nature of the infographic and that there was a need to let the elements of the infographic do the talking, whether it was through graphics, charts, or other visual components.

A major constraint that Phillip acknowledged was the lack of opportunities for infographic use during his own schooling experience. He mentioned trying to use them in his classroom practicum experiences, but usually was doing so in the form of a consolidation piece. He was the one creating the infographics, not his students. So, he stated that he would like to explore this as a student-driven activity, rather than simply another article for student consumption. Moreover, he found that there was not enough guidance on the creation of his infographics: "the first infographics were just reams and reams of information," but, through reflecting on his work, he was able to improve his ability to condense but still clearly communicate information. His only reported experience involving the use of infographics in his Bachelor of Education coursework was during one Bachelor of Education course assignment.

4.3.2 Luke

Luke differed from Phillip in his opinions during the sorting task, opting to rank the infographics in the order of B, A, C. While they both shared similar feelings towards

infographic C, Luke's perspective differed with regards to the other two infographic products. Concerning infographic B, Luke appreciated the main central image with break off points coming from that image, making it very easy to navigate without being overwhelming. He did not appreciate the numeric focus of infographic A, maintaining that it was hard to identify what the numbers were trying to tell him. Additionally, the base colour was difficult for him. The researcher later found out that he was red-green colour blind, and felt that might have impacted his reception. Finally, like Phillip, he felt infographic C was too messy and confusing. From the font sizing to the colours in the legend being very similar, he was left unable to decode infographic C.

Luke acknowledged that his preference for infographics as a communication tool in the classroom stemmed from his desire to teach and work with English Language Learners (ELLs). He felt that infographics were not only more engaging for this population of students but offered more opportunities for these learners to make connections to the material being taught through the use of a more universally accepted language like icons, and images. He outlined that the multimodal nature of the infographic enabled it to "summarize all of those findings into something that is both visually appealing and provides information" working to tie these elements together for a more holistic learning experience. As Luke progressed through the study, he continued to use infographics in his coursework as well as practicum classrooms. He saw the potential growth opportunities for his students' twenty-first century competencies and digital literacies skills, especially for those who did not have English as their first language. He closed with this final thought: "I think there's more of a reach when you're using infographics than images and words alone."

A main drawback to infographic use for Luke was the difficulty that he foresaw with properly sourcing the data being used in the final product. As a Primary/Junior teacher, he felt that this might be a skill that was too advanced for his prospective students. While he felt that they could complete the other aspects of infographic creation, he felt that the referencing and ethical considerations for this type of task might be too complex. In addition to creating the citations being difficult, he felt that his students would be challenged when it came to narrowing down “a vast amount of sources” and how to “communicate things in a succinct way.” He also pointed out the need for students to reflect on the work they were producing and try to ensure that “they were not overlapping information” because they were trying to use data that they collected from two different sources.

4.3.3 Eric

Eric chose to rank the infographics in the sorting task in the same order as Luke, B, A, C. He felt that infographic B was very clear, using a few lines to draw the reader’s eye to the different information. He said, “as a teacher I like this one the most, because it has all of the visual things, it makes it easier for children to be at least interested in looking at it in the first place.” By visual things, Eric expanded to mean the main central image, clearly laid out banner with the title of the infographic, and lines to lead the reader to various textual explanations. He recognized the importance of the aesthetics of the infographic and used that as a point for commenting on the other two infographics as well. When considering infographic A, he noted that as a math-minded individual, he felt this one appealed to his learning preference the most. He also mentioned his distaste for the word cloud because he

felt it was messy and ineffective as a visual tool. He immediately identified infographic C, as “the one I hate the most.” Eric was quickly overwhelmed by the amount of data present in the infographic and felt that there was almost no attempt made by the author to condense the information into a manageable amount for the reader. He emphasized the importance of not overloading the reader and he felt that infographic C failed in that respect.

When it came to identifying the affordances of infographics, he really emphasized the engagement level of infographics. During the phase two interviews, Eric mentioned the potential for engaging students and authors through infographics as a communication tool. He noted, “you have to capture the audience’s attention...if you have a specific audience in mind, appeal to them.” Through the planning process, he recognized that it was not only about creating something that was meaningful to himself as an author, but that captures the attention and interest of the audience that the infographic is being shared with. He thought it was important to teach students to be aware of the potential power of not only the information that they are sharing, but also the way that they chose to display the data was just as important as the content itself. Moreover, infographics offered teachers the ability to scaffold learning for their students. He recognized that though infographics may work for some students easily, there is “differentiation, some students might understand and relate to infographics more than others,” so it offered an opportunity for students to collaborate and build their skills as a team. It allowed for students to highlight different personal strengths or shortcomings, and work together to create a product that fulfilled the goals that they were striving for, while working towards developing all of their twenty-first century competencies.

When critically reflecting on infographics as a teaching tool, Eric felt that the biggest constraint was the requirement for students to condense and present content in this medium. His experience showed him that with students “there’s either, it’s too focused on something, where they aren’t expanding on information...or it’s too giant, where there is too much information.” As a Primary/Junior teacher candidate, he, like Luke, felt this would be an area of difficulty for the students he hoped to teach one day. However, he said he would work through this by providing his students with more explicit guidelines to try and help them work through the research and design processes.

4.3.4 Jake

Jake came to this phase of the research with a different perspective from his peers as he was a teacher candidate in the Intermediate/Senior division, so his perspective reflected the needs of that older student population. He ordered them in the same way that Phillip did, infographic A, B, C. He noted that infographic A was the clearest and most neatly organized of the group. Jake liked that there was a nice balance of graphics and words to effectively communicate its message. While he felt the visual appeal was there for infographic B, he did not like how it relied solely on text to propagate its message. He felt that the infographic could benefit from more thoughtful use of pictures or graphs to display the data that was being shared. For infographic C, he struggled to find any meaning or purpose to the infographic. Jake was not willing to spend the time to try and dissect and decode the infographic. He felt that defeated the purpose behind the use of this type of communicative tool.

A main affordance that Jake mentioned was the ability for infographics to reinforce digital literacies skill development not only for students, but also for him as a teacher as well. He identified that “creating an infographic required the use of researched and/or prior knowledge to construct a visual that created a new perspective to consider the same topic, or new approaches to summarize it.” He felt that infographics allowed for the widening of perspectives, both for the author and audience of the final artifact. He further went on to explain that infographics “allow students to construct knowledge and it places the information in the hands of the students allowing them to use their own knowledge, researched knowledge and areas of interest to create a unique representation of the topic at hand.” Additionally, Jake noted that through the use of these different knowledge banks, authors and consumers are often more engaged, which would likely increase the capacity for learning.

Another clear benefit for Jake was that through projects involving infographics, teachers were encouraging the development of critical thinking, innovation, and creativity skills, which were all identified by Jake as twenty-first century competencies to be taught in the classroom. During the phase two interviews, he stated, “creativity, innovation, where they ask you not just what is the topic, but how could you organize it or how could you classify it to make it have some sort of meaning behind it.” At this time, Jake also noted that these skills were inherent in the use of infographics, whether students were creating them personally or simply consuming information from them. He felt that students would be forced to draw on their metacognitive skills and reflect not only on the works they were creating, but also potentially on the final products being presented to them.

In Jake's opinion, the biggest constraint for infographic use in the classroom was access to technology. Like Eric, he noted that he had more control over this issue during classroom hours but, when considering an infographic as a study tool or homework assignment, he was not always aware of whether or not his students would have equal opportunity to access these tools at home. Additionally, since not all students have the same access to digital tools, he wondered about whether there would be gaps in technological understanding that would render infographics useless to some students.

4.4 Phase Three: Teacher Candidate Created Infographic Artifacts

Phase three of the research study was completed independently of the researcher. The teacher candidates were able to choose a topic that was of interest to them and create an infographic for whatever purpose that they saw fit. There were few guidelines set by the researcher during this phase in order to give the participants free reign on what they would produce. This was done in hopes of eliciting a more authentic and purposeful final product rather than one that was prescriptive, like the teacher candidates may have previously experienced during their Bachelor of Education coursework. All of the participants were encouraged to use the online freeware Piktochart (Piktochart, 2018) for the creation of their infographic artifacts. They were assessed against the Infographic Matrix (Figure 9) created by the researcher.

4.4.1 Phillip

Phillip chose to focus his infographic on encouraging children, specifically students, to spend more time outside. His project was titled, "Take Me Outside" and it opens by

asking the reader “do you remember playing outside until the sun set?” He then follows this with some very easy to absorb statistics that offered some shock value to elicit further interest from the reader (Figure 12).



Figure 12. Screen grab of upper section of Phillip's Infographic

Phillip continued his infographic by explaining Nature Deficit Disorder, by outlining the causes and effects that this has on children. To further drive this idea home, he then listed ten reasons kids need fresh air. When considering the design portion of the infographic matrix, he created his infographic in the portrait layout, allowing the reader to follow his ideas in a logical progression down the page. Phillip used headings to help organize his information and provide clarity of concepts for his readers. Each of the panels alternated between an image involving the outdoors, like trees with a bicycle (Figure 12) or children playing outside, and either a solid dark blue or white background, helping to keep the infographic looking organized. Phillip also tried to appeal to the younger generation

through age-relevant icons, like the emojis used below in Figure 13. These emojis help to support the text below them by prefacing the emotion to be spoken about beneath.

Risky Play - What does a child feel?

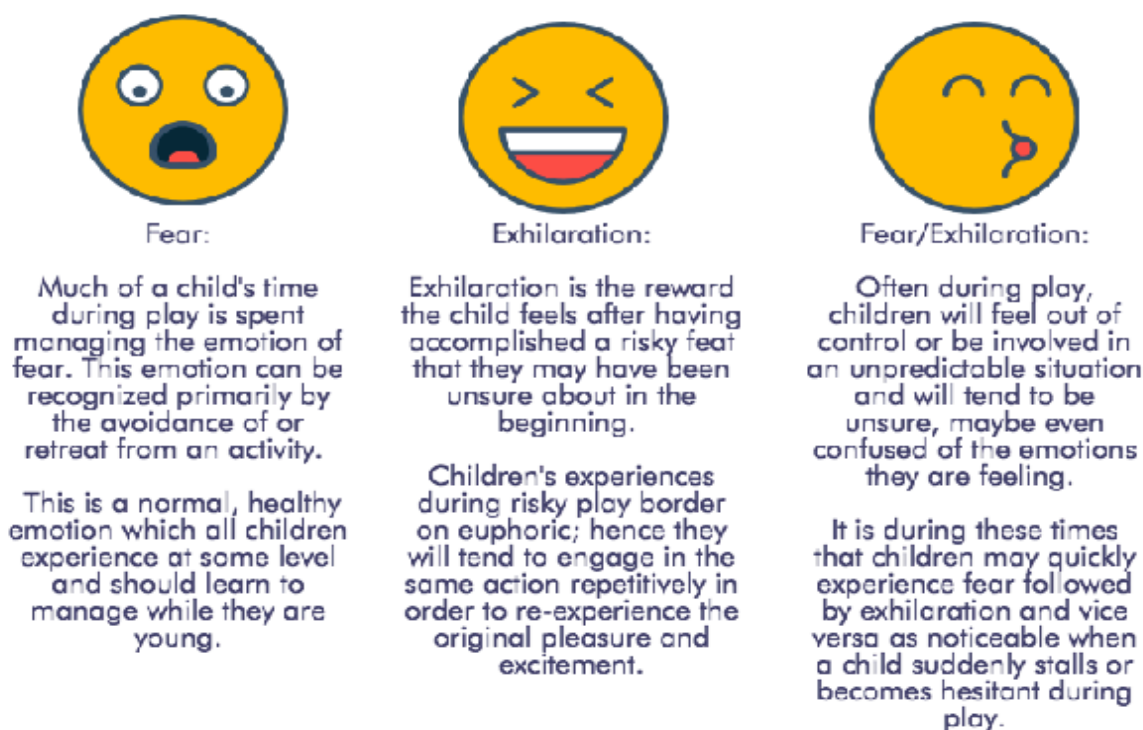


Figure 13. Screen grab of middle section of Phillip's infographic

When considering the utility of his infographic, he chose a clear communicative approach, in that he wanted to tell a reader a story about the issue he was presenting. Not only did the sections of his infographic provide consumers with a strong takeaway message, they also inspired further considerations for the reader to reflect upon. His point of view was clear in the choices he made, both with textual and image choices. From an ethical perspective, Phillip listed the websites he used at the bottom of the infographic for readers to investigate further if they so desired.

At the conclusion of Phillip's infographic project, the reader had been exposed to the ideas of why children should spend time outside, what and how risky play impacts their development, and Phillip's ideas for how this might impact children in the future. He closed off his infographic with a list of the websites where he found his information. There were no grammatical or spelling errors found in Phillip's infographic.

4.4.2 Luke

As a self-proclaimed nature enthusiast and Toronto native, Luke focused his infographic on growing Toronto's urban forest. Similar to Phillip, Luke decided that his infographic would be most effectively shared in the portrait layout, where the information was read from top to the bottom. His information was presented in order of importance, allowing the reader to follow along while maintaining a strong understanding of the content being shared. He chose colours that were appealing to look at, fonts that were easy to read, and made good use of white space throughout the document. Additionally, Luke presented information in such a way that it guided the consumer's eye through the infographic in a way that ensured the reader was getting information in the proper order to be best understood. Additionally, the graphics that Luke used were relevant to the topic being covered and well chosen to serve the purposes of the infographic.

The title of Luke's infographic was "Every Tree Counts: Growing Toronto's Urban Forest." His infographic opens with some key findings about the city centre and its tree populations, as well as some goals that were outlined by the city with regards to growing their urban forest (Figure 14).



Figure 14. Screen grab of upper half of Luke's infographic

Following these statistics and the goals determined by the city, Luke used the latter half of his infographic to outline the importance of this type of development in the city for the Torontonians inhabitants. He discussed combating climate change, potential health benefits, as well as social wealth.

It was clear throughout the infographic that Luke was addressing Torontonians, including parents and educators. This narrative was well thought out and Luke's point of view was clear and consistent from start to finish. He also bolded the main points for ease of readership. Lastly, he chose images and graphics that worked with his overall colour story, and distributed them well throughout the document to provide the consumer with breaks from the text.



Figure 15. Screen grab of lower half of Luke's infographic

In accordance to the ethical section of the Matrix, Luke's infographic ended with the URL for the website used in the curating of information that was shared in the infographic

artifact (Figure 15). Additionally, there was only one error found within the infographic, which could have been edited prior to submission.

4.4.3 Eric

Eric's infographic was created based on his interests in the world of gaming. His infographic was entitled, "You are Invited to Play Some Board Games." Eric was the only teacher candidate to choose to use a landscape layout in the design of his infographic artifact, and continued with his theme by setting up the graphic as a board game for the reader to move through (Figure 16). Although his design was visually appealing, the overall intention was somewhat unclear to readers. The information did not exhibit any real order of importance and the overall title did not really act to clarify this for readers either.

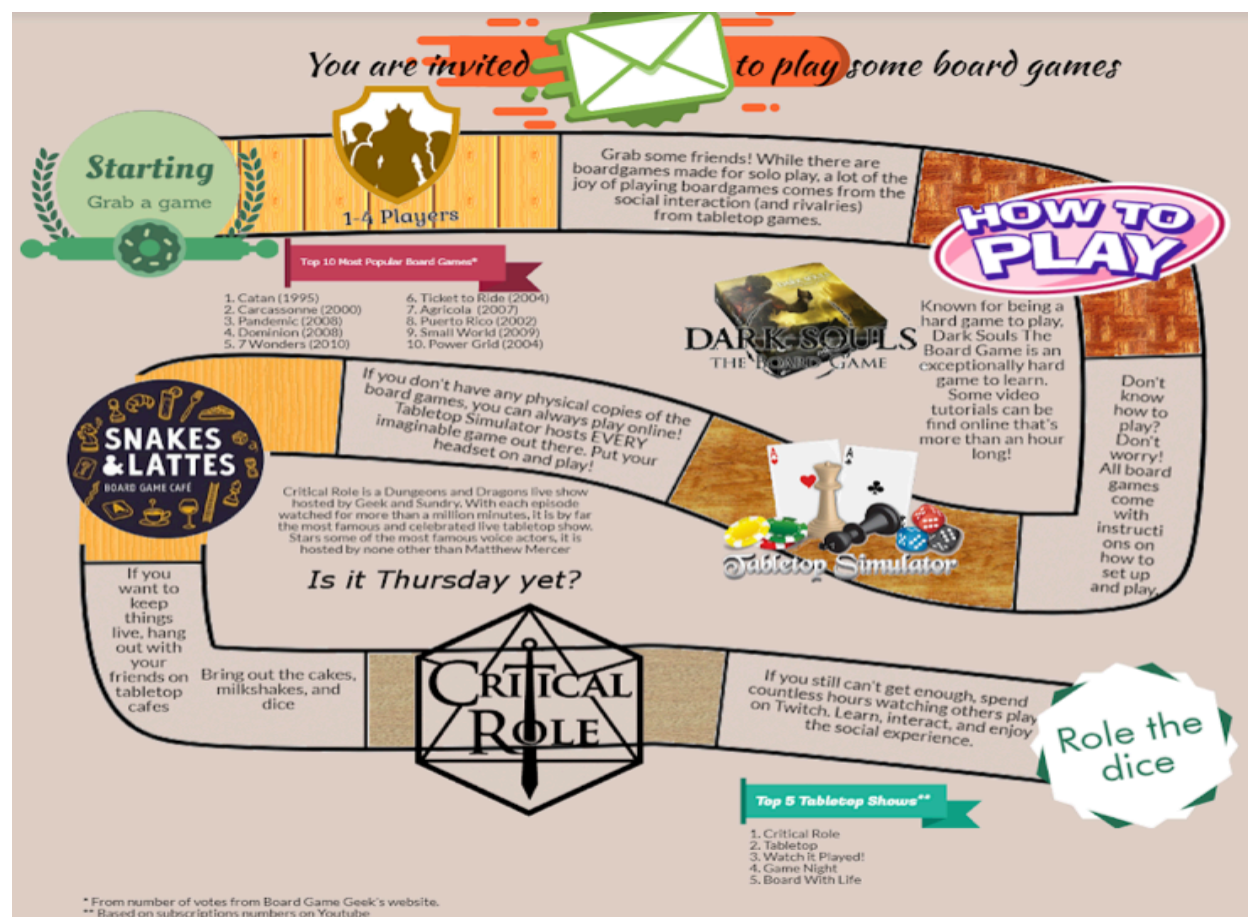


Figure 16. Eric's infographic

Eric's infographic used both images and words to try and communicate with the reader, as well as colour to try and differentiate the pieces of the board. Aesthetically, the layout choice was effective and the text was easy to read on the background colour he selected.

Eric outlined several different facts about board games as well as pointing readers towards other resources, like board game cafes, to explore if they wish to become more involved in the board game community. Though the overall objective of the infographic was somewhat unclear, his chunking of information did make it easy to read. However, since the point of view is vague, readers were left wondering why the information was important for them to know. Finally, as for utility, Eric chose not to add any sort of reference list or citations to his infographic and some errors were found in the text.

4.4.4 Jake

Jake chose to create a more teacher-targeted resource that would help his colleagues and other educators to better understand the psychology behind learning. His infographic employed a portrait layout, and was titled, "Cracking the Learning Code: The Meaning Network." Jake's infographic aimed to take more complex psychological concepts, that may have been taught in undergraduate psychology courses, which he felt many teachers may not have had experienced in their educational journey. Jake recognized the need to present the information in a friendly and visually appealing way, through the use of clearly identifiable titles, while also using language that the layperson would understand. This challenged him to evaluate and reevaluate the terminology he was using as well as the best way to present the data so he would not overwhelm his audience. His data appeared to flow from the most important near the top of the infographic, through to the information that

might be less essential for readers to understand immediately. Along with considering the use of font, colour, use of white space, and other basic design principles outlined in the Infographic Matrix, Jake utilized lines to help break up text and guide the reader.



Figure 17. Screen grab of upper section of Jake's infographic

His infographic followed a specific colour scheme as well as used numbers to help lead the reader through the infographic in a meaningful order.

Jake's infographic was efficient in its ability to clearly outline the purpose. It opened with a small explanation of what consumers could expect to learn from the infographic, to entice readers right away and give them a clear understanding of what they were about to read (Figure 17). The text was broken down into small chunks or paragraphs, so that the reader was able to quickly scan through the information without becoming overwhelmed by quantity. Each chunk of text worked to expand on the last one to provide consumers with a stronger and more complete understanding of the content. Additionally, Jake made it

easy to identify the main points from the rest of the text as he bolded them for ease of reading.

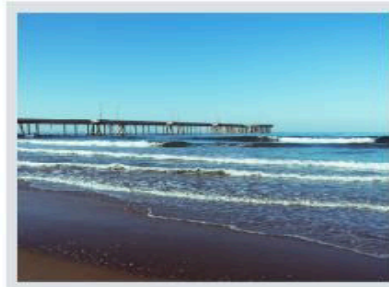
Jake outlined two of the main functions of the brain, attributes of the meaning network, a description of what the meaning network was, and finally, how it related to the field of education and educators (Figure 18). While he explained these complex psychological concepts, Jake utilized language that would be easy to understand for any layperson with little-to-no experience working with psychology terminology. The information was well distributed throughout the infographic and the purpose was clearly supported by the text and visuals.

02 Prioritizing Information

Information that your brain reveals as meaningful, must first be prioritized in working memory, before movement into long term memory.

It prioritizes information based on the intensity of emotional and somatic feedback.

Inclusion into its space is dependent upon information that the brain already holds as meaningful.



03

Attributes of the Meaning Network



No learning occurs without an emotional response.



No learning occurs without a somatic response for the body.



No learning occurs without opportunity to select based on what is relevant.

Figure 18. Screen grab of middle section of Jake's infographic

Jake closed his infographic off with a list of the websites and organizations that he used to find the information he shared in the infographic. He did not formally cite the information in his infographic, but made the resources available for consumers who wished to find more information on the topic. Additionally, there were no errors found in the text in his infographic.

4.5 Phase Four: Post-Research Interviews & Online Questionnaire

For the final phase of the study, the participants returned to the research lab with the researcher to participate in a final one-on-one interview. The first eight questions for this interview were the same for every participant. The final questions varied based on the responses given during phase two as well as after content analysis was completed on the infographic artifacts that were submitted to the researcher. Both sets of questions are found in Appendix G. This was done to gain a more complete understanding of the decisions that the authors made while creating their infographic.

Lastly, the teacher candidates were asked to fill out an online questionnaire that focused on a similar set of open-ended questions to the phase one pre-research questionnaire. This allowed the researcher to compare the opinions and growth for each of the participants from the beginning of the study to its conclusion.

4.5.1 Phillip

In the post-research interview and questionnaire, Phillip's opinions of the efficacy of infographic use did not really change. He stated, "I still think that infographics are very

important in terms of being able to display information and hitting multiple learners at multiple stages.” His focus remained on the multimodal nature of infographics as a strength of their communicative potential in the classroom environment. He not only felt that this tool was a potential benefit for learners, he saw it as an evolution of the current curricular content, stating, “it’s a natural extension of a lot of the projects that exist in a lot of curricula, which is to ‘create a poster’.” He saw this as a way to meaningfully utilize technology to facilitate learning, not just as a way to push technology into existing educational programming.

Phillip also mentioned that his experience in the infographic creation in this study forced him to develop his personal digital literacies skills, including how to “focus on content and being concise in my message.” Along with developing his digital literacies skills, he was able to see an impact on his twenty-first century competencies as well. He said “it also helped me to be more creative with the output,” which pushed him out of his comfort zone with more traditional communication tools. Additionally, Phillip felt that through infographic creation, students could be better encouraged to be subjective and consider the audience they are producing the infographic for. Thus it elicited the ability to see through others perspectives in a way that Phillip did not think traditional literacy assignments necessarily did.

He expressed that the only constraint to educator engagement in infographics were “only what the educator places onto themselves.” Phillip emphasized that regardless of the student level, grade, or subject being taught, teachers could craft any assignment, whether during the learning process or as consolidation, into an infographic. He felt that the level of

complexity or lack of buy-in for the tool was more the fault of the teacher than the infographic.

4.5.2 Luke

In the post-study questionnaire, Luke acknowledged that while his opinions of using infographics in the classroom had not changed, he felt that through the research study his understanding of digital literacies and communication through infographics improved. Specifically, he noted that through the infographic creation process, he found that the activity challenged him to better locate and synthesize information. Luke commented, “I think building that skill of synthesizing information or adding your own spin to the research, your creative elements, it builds those skills that you want to see in your classroom, in your students.” He emphasized that, through this tool, authors are forced to really dissect the information that they are presenting and work with it to find a way to ensure the most clear and effective communication with the audience. As communication is a twenty-first century skill to be developed in the classroom, Luke saw infographics as a seamless way to encourage this proficiency from his students in a way that was non-threatening to the students, especially the English Language Learner population.

Secondly, Luke recognized the potential as an educator to employ the principles of Universal Design for Learning through infographics. He felt that infographics offered students a level of flexibility that may not traditionally be found in text-based communication tools in literacy assignments. He stated that infographics could “tie visuals and text together” in a way that was more accessible to a wider range of students. He also alluded to how good children’s authors used pictures and words to communicate with the

learner population. He mentioned, that like with picture books, images and text work to “incite curiosity for further learning,” which was a twenty-first century skill that educators should strive to encourage from students regardless of the subject being covered.

A main drawback to infographics, in Luke’s opinion, was that he noticed he would more often take an infographic at face value. Whether the infographic had references or not, he did not feel the need to delve deeper into the subject through the sources provided at the bottom. He claimed, “I’m going to consume it as valid, not really looking into the background of it, the research behind it.”

Another constraint that he outlined in his post-research questionnaire was the potential lack of access that his future students might have to technology. While he could attempt to provide equal access to technology within the four walls of his classroom, once the students leave, this would be out of his control. There were often computers available during school hours, whether in the learning commons or a computer lab; he questioned whether or not the access would be the same once the school day ends. Based on the technological nature of the infographic and the need for computer or Internet access, he felt that this might limit the effectiveness of this tool in the classroom, regardless of whether it was for production or consumption purposes.

4.5.3 Eric

Eric began by illustrating the ability of infographics to encourage critical thinking and problem solving from the author as well as the audience. From a creator’s point of view, he felt it was really important to reflect on what was being shared and the methods

by which the data was collected. He found himself reflecting during the creation process by asking, “which information is relevant? How do I find that data?” He would then rework the information he had collected or he would search for more. This navigation of the web involved critical thinking and digital literacies skills that he felt were underlined in the infographic creation process. He did not need to explicitly be taught these skills, or have it pointed out these that critical thinking or digital literacies skills were being used, it was inherent in the creation of his phase three infographic. With this in mind, he acknowledged that he would probably use infographics for evidence of learning from his students because there were clear metacognitive opportunities for students to express their knowledge. From an audience’s perspective, there was an analysis that must be completed when reading or consuming an infographic. He said that readers should look for elements like referencing, and more specifically what was being referenced, before truly accepting the information being presented.

On the other hand, one of the main constraints that struck Eric was the potential ethical implication of taking images and graphs off of the web. While he acknowledged that through proper referencing, the author was attributing the information to its source, he questioned whether or not that was still sufficient for something that was copyrighted. With that in mind, Eric felt that the students would need some proficiency in online design software or with traditional visual arts skills to create the visual elements that would be used in the infographic, which may be too far beyond the grade levels of the students he would likely be teaching.

4.5.4 Jake

While Jake felt that this research study was a good opportunity to try to develop some new skill sets while in his studies, he admitted to not really venturing too far out of his comfort zone when it came to creating his final infographic artifact. Due to the time constraints and requirements of his Bachelor of Education coursework, he stuck to using tools and subject matter that were familiar to him. Jake acknowledged that he used a lot of resources that were built-in to the infographic tool Piktochart (Piktochart, 2018) and did not really search very far past what was immediately available through that site as well as the search engine Google.

The main benefit that Jake took away from his participation in this research was the potential for this tool to engage learners in a non-traditional literacy-based task. He felt that infographics provided a “unique way for students to bring information together” while meaningfully incorporating technology into the learning process. He asserted that through infographic creation, students were learning digital literacies skills – including critical thinking, innovation, and problem solving – in order to create the best final product that they could. Through the process of gathering and sorting of data, students were engaging in these critical cognitive thinking tasks that encourage deeper learning of the content. They then had to take what they had learned and display it in a creative and meaningful way that a reader would be interested in consuming.

However, Jake was the only participant to acknowledge that he felt infographics were not the “be all to end all” tool for creating and thinking about information. Unlike his peers who were more ready to immediately engage in the use of infographics in the learning

environment, Jake recognized that infographics are “a type of digital technology that students can use to creatively bring their information together in a way that’s more engaging or visually appealing,” but he also believed that there were other tools in an educator’s repertoire that could perform similar functions. Jake recognized the educational potential for the tool though and asserts that he may offer it as an option for students to choose for the submission of course projects. This way, students who are interested in the communication medium are offered the opportunity to explore them, but if they are more interested in another modality, he would be willing to let them investigate and create that instead.

4.6 Chapter Summary

This chapter served as a compilation of the research results that were found throughout the four phases of the study. Analysis of the pre-study questionnaire, the videos of the infographic sorting task, the transcriptions from the one-on-one interviews, and the teacher candidate created infographic artifacts, were all included as useable data. The data from each phase of the research acted to explore the research questions proposed at the beginning of the chapter, to deeper the understanding of the potential for infographics as a communication tool to be used by the teacher candidates in their future practice. Through in-depth case study analysis, participant voices could be explored and their growth and perspective shifts were evident throughout their participation in the study. In the following chapter, the results will be discussed in greater detail.

5 Discussion

5.1 Overview

The purpose of this research study was to examine the impact of the use of infographics as an alternative communication tool for teacher candidates to consider for use in their future classrooms. As highlighted in the literature review, there had been little research into the affordances and constraints for use of infographics in kindergarten to grade twelve classrooms; there had been research conducted through several post-secondary studies (Vanichvasin, 2013; Matrix & Hodson, 2014; Sudakov, et al., 2014; Mendenhall & Summers, 2015; Lyra, et al., 2016; Ozdamli, et al., 2016). This study involved participants from a Bachelor of Education program in Southern Ontario, and explored their opinions and participation in relation to infographic use in their future teaching. Four research questions were addressed:

1. What affordances and constraints exist for teacher candidates who engage in the consumption and production of infographics?
2. How does the reading and writing of infographics help teacher candidates develop their digital literacies skills?
3. How does the creation of infographics intersect with the development of twenty-first century competencies, such as multimodal communication, creative and critical thinking, collaboration, problem solving, and cultural and global citizenship?
4. In what ways do teacher candidates envision using infographics in their own teaching?

This chapter will discuss the findings of this study as they relate to the research questions, and within the context of the research collected for the literature review. Specifically, the discussion will focus on the research concepts: 1) Engaging in the consumption and production of infographics; 2) reading and writing of infographics to develop digital literacies skills; 3) creation of infographics and the intersection with twenty-first century competencies; and 4) teacher candidates further use of infographics. The discussion will also address the educational implications, limitations of this study, and potential considerations for future research.

5.2 Engaging in the Consumption and Production of Infographics

The teacher candidates reported both affordances and constraints of engaging in the consumption and production of infographics. While they found many benefits to their use in the classroom, (i.e. higher levels of engagement, meaningful technology integration into literacy-based subjects, and the reinforcing of both twenty-first century and digital literacies skills), they also acknowledged some very important drawbacks. The main constraint of infographic use was based on a perceived lack of meaningful professional development with the use of digital tools in the classroom.

The teacher candidates were all quick to identify the fact that students tend to be more engaged in the classroom when there was meaningful incorporation of technology into the learning experience. This finding aligned well with the research being conducted with regards to student engagement in the classroom. The literature made it clear that there was a relationship that existed between student academic success and their engagement levels in the classroom (Nelson Laird & Kuh, 2005; Robinson & Hullinger,

2000; Chen, Lambert & Guidry, 2010). However, the literature did not stop at just basic engagement levels. Sadik (2008) reinforced that when technology was used effectively during the learning tasks, student engagement was also increased. Like the participants mentioned, they were able to see that their students were more interested in task completion, and in Luke's case, students were completing extra-curricular research and presenting it in the form of an infographic because their interests lay outside of simply what was being covered in the classroom. This behavioural engagement (Fredricks, et al., 2004; Henrie, Halverson & Graham, 2015), more easily understood as observable student activity, appeared to the teacher candidates as being increased through the use of this learning and communication tool.

In addition to the potential gains in engagement levels through effective technological use in the classroom, the teacher candidates mostly agreed that the use of infographics through this research study helped them to further develop their professional practice. They viewed the consumption and production of infographics as a way to challenge their understanding of education-related technology tools, as well as keep their twenty-first century skills up-to-date. The research highlighted that students were consistently finding novel ways to interact with and leverage technologies to suit their interests and needs (Eshet-Alkali, 2004; Knobel & Lankshear, 2007; Alverman, 2008; Moje, et al, 2008; Jones & Hafner, 2012; Jocius, 2013; Barton & Baguley, 2014), so the next logical step would be to have teachers do the same. Since students are expanding their understanding of the technological world, teachers should be similarly encouraged to ensure that they are also remaining current and effective in their practice.

The research also shows that even though students are exploring these tools and developing these competencies, they are underutilizing this knowledge and understanding when they step into the classroom (Alvermann, 2002; Gee, 2003; Kress, 2003; Hughes, 2009). This was a major constraint for the participants because they could see the educational benefit of these digital tools, like infographics, in the classroom, but felt that teachers did not receive enough professional development to feel comfortable using them in their daily practice. So, while there is some exploration of these types of tools in the Bachelor of Education program, it seemed that the teacher candidates in this project wanted more opportunities to utilize these tools during their time as students in teacher education. The teacher candidates mentioned being shown these types of tools during their time in the program, but they desired more opportunities to create digital artifacts and meaningfully interact with the tools being presented to them. All but one participant had only used an infographic for one assignment, in one class as a part of their learning, and many identified the need for more exposure and time to investigate these tools for themselves and their students.

Teachers' current comfort with using traditional teaching methods also came up as a topic for discussion in this research. The teacher candidates recognized, like Kos & Sims (2014), that there are many underlying similarities between an infographic and other forms of communication, such as essays. Infographics have the potential to offer students a more diverse and exciting way to present information in a way that is simply not possible with a more traditional five-paragraph essay (Kos & Sims, 2014). Phillip agreed with this notion when he said, "an essay is really boiling down someone's thoughts into as little as three paragraphs, with an opening and concluding statement being made. An infographic,

it's the same thing, you are taking a person's idea but now representing it multimodally."

He emphasized the need to better understand the message the author is trying to get across and communicate it in a way that is more engaging for the reader than text alone. Luke also agreed noting, "we [the author] have a thesis, which is the idea we want to get across...then you [the author] have your main points, which have sub-points within their subheadings and those can be demonstrated through pictures and words." He recognized that there is still a main idea [the thesis] that needs to be supported by the information provided throughout the infographic. The data is just being presented in a way that "makes it more engaging and accessible to English Language Learners and more students." Jake also agreed that there were similarities between the communication tools. He articulated that, "an infographic allows students to take that sorting and classifying of information even further than an essay would because you force them away from the five-paragraph structure and towards different ways of presenting information." As a science educator, he saw the benefit of teaching students to communicate and explore ideas in a multitude of formats. Eric, however, did not agree with his peers. He felt, "there is a big difference between an essay and an infographic, it's in the way you condense your information." He felt that there was more room for students to elaborate and explain their thoughts through an essay format rather than through an infographic. Eric believed that infographics were better used to highlight key points about a topic, whereas essays were more effective in allowing students to really explain their understanding of a topic.

5.3 Reading and Writing of Infographics to Develop Digital Literacies Skills

The teacher candidates were unanimous in identifying that multimodality and, more broadly, digital literacies skills development, were key takeaways from this research study. They also recognized that organization and ethics were critical abilities to consider and use in their practicum placements and future professional practice. Through the interviews that they participated in and the infographic artifacts they submitted, it was clear that their opinions did not always match what the participants actually put into practice.

The benefits of using multimodal works in the classroom have been extensively researched in the field of education (New London Group, 1996; Lankshear & Knobel, 1998; Cope & Kalantzis, 2000; Kress, 2000, 2003; Knobel & Lankshear, 2007; Hughes 2009), so the fact that the teacher candidates recognized its importance is not surprising. The participants felt that they could investigate different topics on a deeper level when they were able to explore them through not only words, but also images, videos, graphic data representation, and audio (Mills, 2010; Walsh, 2010; Jocius, 2013; O'Byrne, 2014). Mostly, they agreed with the literature in that through multimodal representation, the students, and they themselves, would be better prepared for the requirements of today's workforce (Dusenberry, Hutter & Robinson, 2015) by engaging in deeper learning of the content being presented in this multimodal fashion (Gee, 1996; Kress, 2003; Buckingham, 2007b; Jewitt, 2008; Mills, 2010; Jocius, 2013; Williams, 2014; Dusenberry, Hutter & Robinson, 2015; Matrix & Hodson, 2017). Moreover, through multimodal education and communication, teachers are encouraging students to develop into better communicators (Jewitt, 2008;

Binkley, et al., 2012), which was an idea that all of the participants agreed upon and mentioned. All of the teacher candidates were clear in their support of the importance of multimodal communication, which aligned with the literature (New London Group, 1996; Kress, 2000, 2003; Nixon, 2003; Alvermann, 2009; Albers & Sanders, 2010; Hughes & Tolley, 2010; Jocius, 2013; Eteokleous & Pavlou, 2015) as well as what they were being taught in their teacher education program.

More interestingly was that even though the teacher candidates all identified both ethics and the condensing of information as important considerations for digital literacies education and infographic creation, this was the area that they seemed to struggle with most when it came to putting theory into practice. Two of the participants admitted that the final infographic that they created probably contained too much information for the layperson to want to consume. While they used appropriate language and visuals in attempts to reach a wider audience, as suggested by Lyra, et al. (2016), the amount of data was potentially going to appear overwhelming to a reader. Furthermore, the participants emphasized the importance of not misrepresenting data through the way the author chooses to present it, which aligned nicely with the research conducted by Eshet-Alkali & Amichai-Hamburger (2004) with regards to manipulation of information to suit a specific purpose.

From a digital literacies standpoint, the teacher candidates all identified proper attribution of information and referencing as highly important skills to reinforce in the classroom. The importance of teaching students the ability to identify false, biased, and irrelevant data and be able to eliminate those as sources for knowledge sharing in their

infographics was clear (Eshet-Alkali & Amichai-Hamburger, 2004). Regardless of this, the participants admitted to sometimes accepting infographics as true at face value and not investigating deeper into the validity of the information. Another area of contention for the participants was whether or not images should be sourced at the elementary school level. However, like Kafai & Peppler allude to in their DIY Production Framework (2011), referencing all original works by properly citing the creator, regardless of whether it is text, video games, cartoons, etc., is an important practice (Perkel, 2008). So, while the teacher candidates' intentions were not to plagiarize original works, it seems to remain a common misconception that only textual works must be referenced. This was a finding that revealed itself during the closing interviews, as the participants acknowledged their oversight in this area, but also recognized that they felt that it was a grey area as far as their understanding of academic ethics were concerned. Luke mentioned, "for the purposes I used referencing for, I think that it [listing website URLs] would be enough", while Eric said, "I think I could have been more formal in my citations." While the instincts and previous education of the teacher candidates allowed them to recognize the importance of referencing in their projects, it was interesting to see how their results did not line up with these ethical beliefs.

5.4 Creation of Infographics and the Intersection with Twenty-first Century Competencies

The literature that is currently available clearly highlights the importance of developing students' twenty-first century skills (Jenkins, et al., 2009; Silva, 2009; Partnership for 21st Century Skills, 2011; National Research Council of the National Academics, 2012; Ontario Ministry of Education, 2017), through meaningful use of technology in the classroom (Sadik, 2008; Fullan & Langworthy, 2014). The teacher

candidates believed that communication, critical thinking, creativity, and innovation were the competencies that were most strongly reinforced through the production and consumption of infographics.

The most easily identifiable twenty-first century skill that can be taught through infographic consumption and production, as acknowledged by the participants, was communication. Infographics offer students the opportunity to make complex information approachable, interesting, and meaningful to audiences (Smiciklas, 2012; Toth, 2013; Lyra, et al., 2016; Ozdamli, et al., 2016), which the teacher candidate participants felt was accurately represented through their experiences with infographics as a tool for communication. Through the creation of an infographic, authors are required to consider not only what information is being presented, but also how to do so in the most aesthetically pleasing way. The participants recognized that since students spend so much of their lives in the online world, it was important for educators to acknowledge the opportunity that digital tools offer for more effective communication, which is supported by research conducted by Alvermann (2009). Finally, the participants as well as the literature (Belk, 2014), mentioned how mass sharing of information, whether as a photo, textual post, or infographic, has become a cultural norm for many students. With this in mind, teachers should be teaching students how to decode multimodally so that they are prepared to navigate today's online communicative environment (Kereluik, et al., 2013).

The next competency that was clear to teacher candidates was the need for authors and audiences alike to engage in critical thinking skills. Individuals who are creating infographics need to critically analyze the information that they want presented so that they can represent those concepts in a multimodal way (Matrix & Hodson, 2017). This was

an element of infographic production that all of the participants identified as something that may be difficult for their students. Phillip acknowledged, “it is really about understanding the impact on non-verbal or visual content on their infographics, not putting pictures for the sake of putting pictures. There needs to be a meaning behind it, a purposeful connection.” Eric identified how students need to, “make sure that the information you [the student] has is concise and relevant and pin-pointed to a certain material that you want to show.” The teacher candidates recognized the needs for their students to have strong critical thinking skills, and noted how it extends past simply reading text off of a page. However, the artifacts provided in phase three of the research showed that it was an element of difficulty for some of the participants as well. Luke mentioned his willingness to take an infographic at face value, recognizing that he was not putting his critical thinking skills to use. This was something that he became more aware of through the phases of this study and identified as a personal area for growth by the end of his participation in the thesis. Research shows that multimodality encourages the development of these types of critical thinking skills (Albers & Harste, 2007), but the participants outlined this as a potential area for more education to be provided to teachers so that they can be better prepared to assist their students. They acknowledged the need for meaningful selection of modalities to convey meaning, which is also supported by research (Walsh, 2010; Jocius, 2013; Barton & Baguley, 2014).

5.5 Teacher Candidates Future Use of Infographics

The idea that through engaging with infographics as a communication tool, they would be potentially reaching a wider variety of students resonated with the participants

in this study. Through the multimodal nature of the tool, the teacher candidates felt that the use of images, text, video, audio, and other modalities would appeal to the students' varying learning preferences, and thus would provide a more meaningful learning experience. Eric noted, "as a teacher evaluating an infographic, you get an idea of what students value the most... they get to choose what they present," which may give students a greater feeling of autonomy in their learning. Research in education and literacy has extensively shown that the connection of representational systems aids in the meaning making process (Gee, 1996; Kress, 2003; Buckingham, 2007b; Mills, 2010; Jocius, 2013). By encouraging our students to engage in these processes at a younger age, and providing them with chances to develop and use these skills in their learning, we are working to improve their understanding of literacy as it extends beyond simply reading and writing traditional print text.

Another affordance that the teacher candidates were quick to acknowledge was the potential for infographics to encourage STEAM education in the classroom. Whether working from a multimodality standpoint or encouraging students to use the design process while working, they are being taught to engage in their literacy education in a way that is sometimes absent from the traditional learning environment. STEM educators are often tasked with providing their students with ample amounts of data, so by empowering them to address the A [arts] in STEAM education, they are better able to tackle cross-curricular teaching while also supporting literacy development for their students. By eliciting this design thinking in subjects that are not typically linked to engineering, students are being taught to utilize the twenty-first century competencies that we are teaching in ways that are effective for learning. These skills can also be reimagined to be more industry relevant and specific later on in their careers.

An interesting way that the teacher candidates envisioned using infographics was for evidence *as* learning and evidence *of* learning. Phillip and Jake recognized the educational potential for the use of infographics as a consolidation tool, whether as a study tool for students to use or as a summary at the conclusion of a unit. They both acknowledged having used infographics for this purpose previously, and felt that this was an applicable and efficient way of not only using this tool in their classroom, but also to introduce their students to multimodal communication for creation later on in their learning. Luke and Eric on the other hand saw infographics as a tool to gauge where students were in the learning process. They recognized the affordances that this multimodal communication tool could offer educators in relation to keeping track of student understanding and progress throughout a unit of study.

All of the teacher candidates emphasized that they would be using infographics in some fashion in their future classrooms. Luke and Phillip noted that they were currently using them as a communication tool in their teaching. Eric commented that he felt that infographics would be a good alternative way for students to show their learning of curricular content. Finally, Jake believed that infographics could be beneficial when paired with a larger research project, or as a direct teaching tool to introduce concepts in his science classroom.

5.6 Educational Implications

Infographics have potential as a communicative tool in kindergarten to grade twelve classrooms. Infographics support digital literacies education, twenty-first century competencies development, multimodal thinking and design (Lankow, Ritchie & Crooks,

2012; Siricharoen, 2013; Lazard & Atkinson, 2015; Polman & Gebre, 2015; Thompson, 2015). They leverage students' interests, and capitalize on the effective use of technology in the classroom environment. Infographics are able to teach a plethora of skills to students, but without teachers who are willing to engage with and learn how to leverage these tools, students will be limited to only a few ways of communicating their learning and understanding. Education will continue to rely on traditional assessment tools like essays, tests, and final examinations, which, as research has shown, are not the most effective or authentic methods of communicating understanding and knowledge acquisition (Buckingham, 2007a; Philip & Garcia, 2013; Fullan & Langworthy, 2014; Henthorn & Cammack, 2017).

However, while they are an effective tool for literacy engagement and communication, infographics cannot entirely replace other teaching techniques and pedagogical strategies. For example, while infographics inherently teach similar skills as a traditional essay, learning how to write a proper essay is currently a requirement of post-secondary institutions, maintaining its relevance in the kindergarten through grade twelve classrooms. Though this necessity still exists, the teacher candidates acknowledged the potential impact that infographics could have on student engagement and their ability to communicate information. Unlike with an essay, where students write for someone who is familiar with the content, an infographic can be an effective communication tool for someone with absolutely no experience with the information being presented. This forces students to really reconsider how they are sharing information with a consumer, and what is the most effective modality by which to share this information.

Lastly, technology integration is a pedagogical concept that is embedded into the teacher education accreditation guidelines in accordance with the Ontario College of Teachers (OCT). According to the *Accreditation Resource Guide* (2017), to teach effectively with technology, teacher candidates need to not only understand how to represent ideas and curricular content, but also how to leverage the tools to improve and facilitate the learning process. Through early introduction to technology tools, like infographics, teacher education programs could better prepare teacher candidates for their future practice.

5.7 Limitations and Future Research

5.7.1 Overview

While every effort was made to ensure that this study was completed in an ethically sound and valid study, there were a few limitations to the research that were recognized. Future research should consider how and when to better engage with the teacher candidate populations. Considering this study took place while the teacher candidates were currently completing their in-class lectures and assignments, their attention was more focused on their coursework. In addition to this, the participants had limited time to gain experience with the online infographic creation platform as they had deadlines to meet for their Bachelor of Education studies. Lastly, the current level of acceptance and utilization of infographics in the classroom made practical use of infographics difficult for the teacher candidates. Regardless of whether or not they wanted to use these tools in their practice, they were required to follow the lead of their associate teachers who may have been less willing to welcome new technologies and pedagogies into their classrooms. These

limitations all affected the outcomes of this study and should be considered for future research pertaining to this population or subject of study.

5.7.2 Limited Participant Population

As this study took place while the teacher candidate participants were currently enrolled in their teacher education program, the time commitment to the research study became a secondary concern. As a result, the study lost six participants by the time the final phase of data collection came. Though the data collected from the four final participants, the additional perspectives from the other teacher candidates would have led to richer data analysis and comparison. Additionally, it is important to note that the only participants to finish the study were male. The selection of only men for case study comparison was not intentional, and was thus not representative of the entire teacher candidate population in this cohort. Given the sample for this study was teacher candidates in a teaching role, the results cannot be generalized for its suitability with younger, less experienced students. Additional research would be required to take place within the classroom environment to test the validity and efficacy of infographic tools with the student population.

5.7.3 Time Constraints

Another constraint for the teacher candidates in this study was the amount of time that they had to dedicate to the different phases of the research. Participants reported during the pre- and post-study questionnaires that they had little familiarity with the infographic tool Piktochart (Piktochart, 2018). They were invited to find an infographic creation platform that they were more familiar with, but they all chose to use Piktochart (Piktochart, 2018), as they felt they did not have the time to dedicate to locating and

learning a new tool. With more time, the participants may have benefited from tinkering more with Piktochart (Piktochart, 2018) or being given some professional development on the best practices for use of this freeware platform. Since the participants had both coursework and practicum placements throughout the course of the study, they had to divide their attention and focus on their studies, rather than fully attend to participating in the study. The researcher worked to ensure that the teacher candidates felt that they had the appropriate amount of time to produce their best infographic, which did prolong the completion of the project.

5.7.4 Infographics in the Mainstream Education System

Another significant limitation to this research is the current acceptability and usability of infographics in the mainstream classroom. Since there is still a plethora of research being conducted in the areas of multimodal techniques, new literacies and assessment of these types of digital communication methodologies, teachers may not be currently willing to engage with this type of literary practice. Since this study relied on the use of teacher candidates as participants, they did not have full autonomous control over how they were teaching and assessing their lessons in the classroom. With this in mind, several teacher candidates were encouraged to use more traditional, paper-based assessment and communication tools in their practicum placements.

5.7.5 Future Research Considerations

Future research should consider the importance of multimodality and interactive media as a tool for classroom use. By giving students, and teachers, the opportunities to present information in a way that is not only informative, but visually appealing will make

the consumption of information more engaging for audiences, regardless of their prior knowledge on the subject. With increased attention to the use of these types of tools in the learning environment, we are better able to prepare our students with the skills that are required in the twenty-first century workforce as well as the wider community.

Additionally, reaching out to the associate teachers (AT) that are overseeing the teacher candidate participants and including them in the research could be beneficial. This may give the teacher candidates more freedom to explore the use of these multimodal tools in the classroom. By including the associate teachers, they [the ATs] would potentially feel better prepared to have these tools utilized within the classroom, empowering the teacher candidates to explore the tools more deeply, providing richer data and practicum classroom examples for the teacher candidates to report.

Finally, future research should consider employing a similar intervention in kindergarten to grade twelve classrooms. While this study provided some insights into teacher candidates' opinions on the affordances and constraints of infographics, employing them with a student population may provide interesting and potentially pedagogically impactful results. Through research with the teacher candidates, it seems that infographics would be an incredibly useful tool to use in the classroom, but getting actual kindergarten through grade twelve-student feedback would be an important perspective to consider as well.

5.8 Conclusion

The purpose of this study was to explore the affordances and constraints of infographics use as it pertained teacher candidates and their future classroom practice. This was accomplished through a small-scale, case study project involving four teacher candidates during their time in their Bachelor of Education program. Through the time spent completing the four phases of this research study, teacher candidates were able to explore their perceptions of infographics as a communication tool and their potential future use in the classroom environment.

This research study encouraged teacher candidates to participate in the investigation and creation of infographics to explore a topic of interest to them. The research emphasized the importance of students developing their digital literacies skills (New London Group, 1996; Lankshear & Knobel, 1998; Cope & Kalantzis, 2000; Kress, 2000, 2003; Knobel & Lankshear, 2007; Hughes, 2009), twenty-first century competencies (Jenkins, et al., 2009; Silva, 2009; Partnership for 21st Century Skills, 2011; National Research Council of the National Academics, 2012; Ontario Ministry of Education, 2017), and points to the advantages of infographics as a communication tool (Clark & Mayer, 2011; Krauss, 2012; Lankow, Ritchie & Crooks, 2012; Smiciklas, 2012; Siricharoen, 2013; Kos & Sims, 2014). So, this study explored those concepts as they related to infographics use with prospective teachers.

At the conclusion of this study, it is proposed that infographics could help teacher candidates to better educate their students with regards to digital literacies, multimodality, and twenty-first century competencies. Interaction with infographics during their pre-

service teacher education program provided the teacher candidates with additional insight into pedagogically impactful ways of incorporating technology into their practice.

Additionally, through the use of the researcher created Infographics Matrix, it is hoped that in-service teachers will begin to recognize the potential of this communication tool. By starting with the Matrix, teachers could develop rubrics or other assessment methods that would allow their students to use and learn with infographics. By outlining the key features for educators to look for, the Infographic Matrix acts to bridge the gap in in-service teacher understanding of infographics, and encourage their exploration and use as a tool in the classroom.

It can be suggested that the use of infographics as a tool for communication is a pedagogical strategy that is worth further investigation. As the shift continues towards technology use and multiliteracies development in the kindergarten to grade twelve school system, it is important that researchers continue to investigate pedagogically meaningful and academically engaging ways to implement these tools in the classroom. Digital technologies offer opportunities for teachers to reimagine their teaching and learning environments. Through acceptance and investigation of these tools during teacher candidates' time in pre-service education, it is hoped that they will adopt and share their pedagogical knowledge with their peers, colleagues, and future students. This way, educators are better able to encourage relevant skill development in their students to prepare them for the world they will enter when they graduate from the K-12 education system.

6 References

- Albers, M. J. (2014). Infographics: Horrid chartjunk or quality communication. In *Proceedings from 2014 IEEE International Professional Communication Conference*, (pp. 1-4). Pittsburgh, PA: USA.
- Albers, P., & Harste, J. C. (2007). The arts, new literacies, and multimodality. *English Education*, 40(1), 6-20.
- Albers, P. & Sanders, J. (2010). *Literacies, the arts, and multimodality*. Urbana, IL: National Council of Teachers of English.
- Alvermann, D. (2002). *Adolescents and literacies in a digital world*. New York, NY: Peter Lang.
- Alvermann, D. (2008). Why both theorizing adolescents' online literacies for classroom practice and research? *Journal of Adolescent & Adult Literacy*, 52(1), 8-19.
- Alvermann, D. (2009). Sociocultural constructions of adolescence and young people's literacies. In L. Christenbury, R. Bomer, & P. Smagorinsky (Eds.), *Handbook of Adolescent Literacy Research* (pp. 14-29). New York, NY: The Guilford Press.
- Anstey, M., & Bull, G. (2006). *Teaching and learning multiliteracies: Changing times, changing literacies*. Newark, DE: International Reading Association.
- Arslan, D., & Toy, E. (2015). The visual problem of infographics. *Global Journal on Humanities and Social Sciences*, 1, 409-414.
- Avgerimou, M. D., & Pettersson, R. (2011). Toward a cohesive theory of visual literacy. *Journal of Visual Literacy*, 30(2), 1-19.
- Bakhtin, M. (1986). *Speech genres and other late essays*. Austin, TX: University of Texas Press.

- Barton, G., & Baguley, M. (2014). Learning through story: A collaborative, multimodal arts approach. *English Teaching: Practice and Critique*, 13(2), 93-112.
- Bateman, S., Mandryk, R. L., Gutwin, C., Genest, A., McDine, D. & Brooks, C. (2010). Useful junk? The effects of visual embellishment on comprehension and memorability of charts. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, April 10-15 (pp. 2573-2582)*, Atlanta, GA, USA.
- Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, 13(4), 544-559.
- Beazley, M., McLeod, J., & Lin, L. (2008). Pedagogical principles, problems, and possibilities in online global classrooms. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education: Part one* (pp. 673-691). New York, NY: Springer.
- Belk, R. (2014). You are what you can access: Sharing and collaborative consumption online. *Journal of Business Research*, 67, 1595-1600.
- Berg, B. L. (2007). *Qualitative research methods for the social sciences* (6th ed.). Boston, MA: Allyn & Bacon.
- Binkley, M., Erstad, E., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining twenty-first century skills. In P. Griffin, B. McGraw & E. Care (Eds.), *Assessment and teaching of 21st century skills* (pp. 17-66). Dordrecht, NLD: Springer Netherlands.
- Bloom, K., & Johnston, K. M. (2010). Digging into YouTube videos: Using media literacy and participatory culture to promote cross-cultural understanding. *Journal of Media Literacy Education*, 2(2), 113-123.
- Borsheim, C., Merritt, K., & Reed, D. (2008). Beyond technology for technology's sake: Advancing multiliteracies in the twenty-first century. *The Clearing House*, 82(2), 87-90.

- Buckingham, D. (2007a). *Beyond technology: Children's learning in the age of digital culture*. Cambridge, UK: Polity Press.
- Buckingham, D. (2007b). Digital media literacies: Rethinking media education in the age of the Internet. *Research in Comparative and International Education*, 2(1), 43-55.
- Chandler-Olcott, K., & Mahar, D. (2003). "Tech-savviness" meets multiliteracies: Exploring adolescent girls' technology-mediated literacy practices. *Reading Research Quarterly*, 38(3), 356-385.
- Chen, P. B. D., Lambert, A. D., & Guidry, K. R. (2010). Engaging online learners: The impact of web-based learning technology on college student engagement. *Computers & Education*, 54, 1222-1232.
- Clark, R. C., & Mayer, R. E. (2011). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. San Francisco, CA: Pfeiffer.
- Cohen, L., & Manion, L. (2000). *Research methods in education*. London, UK: Routledge.
- Cooper, N., Lockyer, L., & Brown, I. (2013). Developing multiliteracies in a technology-mediated environment. *Educational Media International*, 50(2), 93-107.
- Cope, B., & Kalantzis, M. (Eds.) (2000). *Multiliteracies: Literacy learning and the design of social futures*. London, UK: Routledge.
- Cope, B., & Kalantzis, M. (2009). 'Multiliteracies': New literacies, new learning. *Pedagogies: An International Journal*, 4(3), 164-195.
- Crabtree, B. F., & Miller, W. L. (1999). Using codes and code manuals: A template organizing style of interpretation. *Doing Qualitative Research*, 2, 163-167.
- Cramer, S. R. (2007). Update your classroom with learning objects and twenty-first-century skills. *The Clearing House*, 80(3), 126-132.

- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches*. Washington, DC: Sage Publications.
- Davidson, R. (2014). Using infographics in the science classroom: Three investigations in which students present their results in infographics. *The Science Teacher*, 34-49.
- Dewey, J. (1938). *Experience and education*. New York, NY: Macmillan.
- Dunleavy, J., Willms, J. D., Milton, P., & Friesen, S. (2012). *The relationship between student engagement and academic outcomes. What did you do in school today?* Research Series Report Number One. Toronto, CA: Canadian Education Association.
- Dusenberry, L., Hutter, L., & Robinson, J. (2015). Filter. Remix. Make. Cultivating adaptability through multimodality. *Journal of Technical Writing and Communication*, 45(3), 299-322.
- Eshet-Alkali, Y. (2004). Digital literacy: A conceptual framework for survival skills in the digital era. *Journal of Educational Multimedia and Hypermedia*, 13(1), 93-106.
- Eshet-Alkhali, Y., & Amichai-Hamburger, Y. (2004). Experiments in digital literacy. *CyberPsychology and Behaviour*, 7(4), 421-429.
- Eteokleous, N., & Pavlou, V. (2015). Integrating the multimedia builder software as an educational tool to deliver fairy tales: Promoting multiliteracies and multimodality. *Journal of Interactive Learning Research*, 26(1), 65-88.
- Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74(1), 59-109.
- Fullan, M., & Langworthy, M. (2014). *A rich seam: How new pedagogies find deep learning* [1st ed.]. London, UK: Pearson. Retrieved from: http://www.michaelfullan.ca/wp-content/uploads/2014/01/3897.Rich_Seam_web.pdf.
- Gee, J. P. (1991). What is literacy? In C. Mitchell & K. Weiler (Eds.), *Rewriting literacy: Culture and the discourse of the other* (pp. 3-11). New York, NY: Bergin & Garvey.

- Gee, J. P. (1996). *Social linguistics and literacies: Ideology in discourses*. London: Routledge.
- Gee, J. P. (2000). Teenagers in new times: A new literacy studies perspective. *The Journal of Adult & Adolescent Literacy*, 43(5), 412-420.
- Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York, NY: Palgrave Macmillan.
- Godwin-Jones, R. (2015). Contributing, creating, curating: Digital literacies for language learners. *Language Learning & Technology*, 19(3), 8-20.
- Green, M. J., & Myers, K. R. (2010). Graphic medicine: Use of comics in medical education and patient care. *British Medical Journal*, 340, 574-577.
- Greenhow, C., & Lewin, C. (2015). Social media and education: Conceptualizing the boundaries of formal and informal learning. *Learning, Media and Technology*, 41(1), 6-30.
- Greenhow, C., Robelia, B., & Hughes, J. E. (2009). Learning, teaching, and scholarship in a digital age: Web 2.0 and classroom research: What path should we take now? *Educational Researcher*, 38(4), 246-259.
- Griffin, M. (2008). Visual competence and media literacy: Can one exist without the other. *Visual Studies*, 23(2), 113-129.
- Henrie, C. R., Halverson, L. R., & Graham, C. R. (2015). Measuring student engagement in technology-mediated learning: A review. *Computers & Education*, 90, 36-53.
- Henthorn, J., & Cammack, P. (2017). Blogging and tweeting in the classroom: Exploring how effective use of new media can help teaching and learning in primary schools. *Teacher Education Advancement Network (TEAN)*, 9(2), 3-13.
- Hughes, J. (2007). Poetry: A powerful medium for literacy and technology development. *What Works? Research into Practice Series*. The Literacy and Numeracy Secretariat, 1-4.

- Hughes, J. (2009). New media, new literacies and the adolescent learner. *E-Learning and Digital Media*, 6(3), 259-271.
- Hughes, J., & Tolley, S. (2010). Engaging students through new literacies: The good, bad and curriculum of visual essays. *English in Education*, 44(1), 5-26.
- Hull, G. A., & Katz, M. L. (2006). Crafting an agentive self: Case studies of digital storytelling. *Research in Teaching of English*, 41(1), 43-61.
- Jacobs, G. (2013). Reimagining multiliteracies: A response to Leander and Boldt. *Journal of Adolescent & Adult Literacy*, 57(4), 270-273.
- Janks, H. (2000). Domination, access, diversity, and design: A synthesis for critical literacy education. *Educational Review*, 52(2), 175-186.
- Jenkins, H. (1992). *Textual poachers: Television fans and participatory culture*. London, UK: Routledge.
- Jenkins, H., Clinton, K., Purushotma, R., Robison, A. J., & Weigel, M. (2009). *Confronting the challenges of participatory culture: Media education for the 21st century*. Cambridge, MA: MIT Press.
- Jewitt, C. (2008). Multimodality and literacy in school classrooms. *Review of Research in Education*, 32(1), 241-267.
- Jocius, R. (2013). Exploring adolescents' multimodal responses to *The Kite Runner*: Understanding how students use digital media for academic purposes. *Journal of Media Literacy Education*, 5(1), 310-325.
- Jones, R. H., & Hafner, C. A. (2012). *Understanding digital literacies: A practical introduction*. New York, NY: Routledge.
- Judge, S., & O'Bannon, B. (2008). Faculty integration of technology in teacher preparation: Outcomes of a development model. *Technology, Pedagogy and Education*, 17(1), 17-28.

- Kafai, Y. B., & Pepper, K. A. (2011). Youth, technology, and DIY: Developing participatory competencies in creative media production. *Review of Research in Education*, 35, 89-119.
- Kereluik, K., Mishra, P., Fahnoe, C., & Terry, L. (2013). What knowledge is of most worth: Teacher knowledge for 21st century learning. *Journal of Digital Learning in Teacher Education*, 29(4), 127-140.
- Knobel, M., & Lankshear, C. (2007). *A new literacies sampler*. New York, NY: Peter Lang Publishing.
- Kos, B. A., & Sims, E. (2014). Infographics: The new 5-paragraph essay. *Proceedings from the 2014 Rocky Mountain Celebration of Women in Computing*. Laramie, WY: USA.
- Krauss, J. (2012). Infographics: More than words can say. *Learning & Leading with Technology*, 5191. Retrieved from <http://eric.ed.gov/?id=EJ982831>.
- Kress, G. (2000). Design and transformation: New theories of meaning, in B. Cope & M. Kalantzis (Eds.). *Multiliteracies: Literacy learning and the deign of social futures*. (pp. 153-161), London, UK: Routledge.
- Kress, G. (2003). *Literacy in the new media age*. London, UK: Routledge.
- Krippendorff, K. (1989). Content analysis. In E. Barnouw, G. Gerber, W. Schramm, T. L. Worth & L. Gross (Eds.), *International encyclopedia on communication*, 1, 403-407. New York, NY: Oxford University Press.
- Krippendorff, K. (2004). *Content analysis: An introduction to its methodology*. Thousand Oaks, CA: Sage Publications Inc.
- Labbo, L., & Place, K. (2010). Fresh perspectives on new literacies and technology integration. *Voices in the Middle*, 17(3), 9-18.
- Lankow, J., Ritchie, J., & Crooks, R. (2012). *Infographics: The power of visual storytelling*. Hoboken, NJ: John Wiley & Sons, Inc.

- Lankshear, C., & Knobel, M. (1998). New times! Old ways? In F. Christie & R. Misson (Eds.) *Literacy and schooling* (pp. 155-177), London, UK: Routledge.
- Lankshear, C., & Knobel, M. (2003). *New literacies: Changing knowledge and classroom learning*. Philadelphia, PA: Open University Press.
- Larson, L. C., & Northern Miller, T. (2011). 21st century skills: Prepare students for the future. *Kappa Delta Pi Record*, 47(3), 121-123.
- Lazard, A., & Atkinson, L. (2015). Putting environmental infographics center stage: The role of visuals at the elaboration likelihood model's critical point of persuasion. *Science Communication*, 37(1), 6-33.
- Leonardi, P. M. (2017). The social media revolution: Sharing and learning in the age of leaky knowledge. *Information and Organization*, 27, 47-59.
- Leu, D., Kinzer, C., Coiro, J., & Cammack, D. (2004). Toward a theory of new literacies emerging from the Internet and other communication technologies. In R. Ruddell & N. Unrau (Eds.), *Theoretical models and processes of reading*. Newark, DE: International Reading Association.
- Liu, C. C., & Chen, I. J. (2010). Evolution of constructivism. *Contemporary Issues in Education Research*, 3(4), 63-66.
- Locker, K. O., & Kienzler, D. (2012). *Business and administrative communication* (10th ed.). Boston, MA: McGraw-Hill.
- Lund, A., Furberg, A., Bakken, J., & Engelién, K. L. (2014). What does professional digital competence mean in teacher education? *Nordic Journal of Digital Literacy*, 9(4), 281-299.
- Lyra, K. T., Isotani, S., Reis, R. C. D., Marques, L. B., Pedro, L. Z., Jacques, P. A., & Bitencourt, I. (2016). Infographics or graphics+text: Which material is best for robust learning? In N. S. Chen, R. H. Kinshuk, P. Resta, D. G. Sampson, J. M. Spector, & C. C. Tsai (Eds.)

Proceedings of the IEEE International Conference on Advanced Learning Technologies (ICALT), (pp. 366-371). Austin, TX: USA.

Marks, H. M. (2000). Student engagement in instructional activity: Patterns in the elementary, middle, and high school years. *American Educational Research Journal*, 37(1), 153-184.

Masterman, L. (1985). *Teaching the media*. London, UK: Comedia.

Matrix, S., & Hodson, J. (2014). Teaching with infographics: Practicing new digital competencies and visual literacies. *Journal of Pedagogic Development*, 4(2), 17-27.

Mendenhall, A. S., & Summers, S. (2015). Designing research: Using infographics to teach design thinking in composition. *Journal of Global Literacies, Technologies, and Emerging Pedagogies*, 3(1), 359-371.

Miller, P. (2001). *Learning styles: Multimedia of the mind*. (ERIC Document Reproduction Service No. ED 451 140).

Mills, K. A. (2010). Shrek meets Vygotsky: Rethinking adolescents' multimodal literacy practices in schools. *Journal of Adolescent and Adult Literacy*, 54(1), 35-45.

Moje, E., Overby, M., Tysvaer, N., & Morris, K. (2008). The complex world of adolescent literacy: Myths, motivations, and mysteries. *Harvard Educational Review*, 78(1), 107-154.

National Research Council of the National Academics. (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st century*. Washington, DC: The National Academics Press.

Nelson Laird, T. F., & Kuh, G. D. (2005). Student experiences with information technology and their relationship to other aspects of student engagement. *Research in Higher Education*, 46(2), 211-233.

- New London Group, The. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review*, 66(1), 60-92.
- Nixon, H. (2003). New research literacies for contemporary research into literacy and new media? *Reading Research Quarterly*, 38(4), 407-413.
- O'Byrne, W. I. (2014). Empowering learners in the reader/writer nature of the digital informational space. *Journal of Adolescent & Adult Literacy*, 58(2), 102-104.
- Ontario College of Teachers (OCT). (2017). *Accreditation resource guide*. Retrieved from: https://www.oct.ca/-/media/PDF/Accreditation%20Resource%20Guide/Accreditation_Resource_Guide_EN_WEB.pdf.
- Ontario Ministry of Education. (2017). *The innovation and learning fund: A guide to implementation*. Retrieved from: http://www.edugains.ca/resources21CL/InnovationLearningFund/ILF_Guide_2017_AODA.pdf.
- Ontario Institute for Studies in Education (OISE). (2011a). How can we prevent high school dropouts? *EdCan Network*. Retrieved from: <https://www.edcan.ca/wp-content/uploads/CEA-2011-FOE-Dropouts.pdf>.
- Ontario Institute for Studies in Education (OISE). (2011b). How best to motivate students. *EdCan Network*. Retrieved from: <https://www.edcan.ca/wp-content/uploads/CEA-2011-FOE-Motivation.pdf>.
- Ozdamli, F., Kocakoyun, S., Sahin, T., & Akdag, S. (2016). Statistical reasoning of impact of infographics on education. In R.A. Aliev, W. Pedrycz, M. Jamshidi, J. Kacprzyk & I. B. Turksen (Eds.), *Proceedings from The 12th International Conference on Application of Fuzzy Systems and Soft Computing (ICAIFS 2016)*, (pp. 371-377). Vienna, Austria: Curran Associates, Inc.

Partnership for 21st Century Skills. (2012). Framework for 21st century learning. Retrieved from:

http://www.p21.org/storage/documents/21st_century_skills_education_and_competitiveness_guide.pdf

Pegado, F., Comerlato, E., Ventura, F., Jobert, A., Nakamura, K., Buiatti, M., ... Dehaene, S. (2014). Timing the impact of literacy on visual processing. *Proceedings of the National Academy of Sciences of the United States of America*, 111(49), 233-242.

Perkel, D. (2008). No I don't feel complimented: A young artist's take on copyright. *Digital Youth Research*. Retrieved from:

<http://digitalyouth.ischool.berkeley.edu/node/105>.

Philip, T. M., & Garcia, A. D. (2013). The importance of still teaching the iGeneration: New technologies and the centrality of pedagogy. *Harvard Educational Review*, 83(2), 300-319.

Piktochart. (2018). *Create beautiful infographics*. Retrieved from:

<https://piktochart.com/formats/infographics/>.

Polman, J. L., & Gebre, E. H. (2015). Towards critical appraisal of infographics as scientific inscriptions. *Journal of Research in Science Teaching*, 52(6), 868-893.

Prensky, M. (2005). Engage me or enrage me: What today's learners demand. *EDUCAUSE Review*, 40(5), 60-65.

Reavy, M. (2003). Rules and the real world an examination of information graphics in Time and Newsweek. *Visual Communication Quarterly*, 10(4), 4-10.

Robinson, C. C., & Hullinger, H. (2008). New benchmarks in higher education: Student engagement in online learning. *Journal of Education for Business*, 84(2), 101-108.

- Sadik, A. (2008). Digital storytelling: A meaningful technology-integrated approach for engaged student learning. *Educational Technology Research and Development*, 56(4), 487-506.
- Schreiber, L. M., & Valle, B. E. (2013). Social constructivist teaching strategies in the small group classroom. *Small Group Research*, 44(4), 395-411.
- Silva, E. (2009). Measuring skills for 21st-century learning. *The Phi Delta Kappan*, 90(9), 630-634.
- Siricharoen, W. V. (2013). Infographics: The new communication tools in digital age. Paper presented at *The International Conference on e-Technologies and Business on the Web (EBW2013)*, (pp. 169-174). Bangkok, Thailand: Curran Associates, Inc.
- Smiciklas, M. (2012). *The power of infographics: Using pictures to communicate and connect with your audiences*. Indianapolis, IN: Pearson Education Inc.
- Sousa, D. A. (2017). *How the brain learns* (5th ed.). Thousand Oaks, CA: Corwin.
- Stake, R. E. (2000). Case studies. In N. K. Denzin, Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 435-453). Thousand Oaks, CA: Sage Publications.
- Street, B. (2003). What's "new" in new literacies studies? Critical approaches to literacy in theory and practice. *Current Issues in Comparative Education*, 5(2), 77-91.
- Sudakov, I., Belsky, T., Usenyuk, S., & Polyakova, V. (2014). Infographics and mathematics: A mechanism for effective learning in the classroom. *Primus*, 26(2), 1-8.
- Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257-285.
- Thomas, E., Place, N., & Hillyard, C. (2008). Students and teachers learning to see: Part 1: Using visual images in the college classroom to promote students' capacities and skills. *College Teaching*, 56(1), 23-27.

- Thompson, C. M. (2015). Creating “visual legacies”: Infographics as a means of interpreting and sharing research. *Communication Teacher*, 29(2), 91-101.
- Toffler, A. (1980). *The third wave*. New York, NY: William Morrow.
- Toth, C. (2013). Revisiting a genre: Teaching infographics in business and professional communication courses. *Business Communication Quarterly*, 76(4), 446-457.
- Trumbo, J. (1999). Visual literacy and science communication. *Science Communication*, 20(4), 409-425.
- Tufte, E. R. (1983). *The visual display of quantitative information*. Cheshire, CT: Graphic Press.
- Tufte, E. R. (1990). *Envisioning information*. Cheshire, CT: Graphic Press.
- Tufte, E. R. (1997). *Visual explanations*. Cheshire, CT: Graphic Press.
- Tufte, E. R. (2001). *The visual display of quantitative information, 2nd edition*. Cheshire, CT: Graphic Press.
- Ültanir, E. (2012). An epistemological glance at the constructivist approach: Constructivist learning in Dewey, Piaget, and Montessori. *International Journal of Instruction*, 5(2), 195-212.
- Unsworth, L. (2001). *Teaching multiliteracies across the curriculum*. London, UK: Routledge.
- Walsh, M. (2010). Multimodal literacy: What does it mean for classroom practice. *Australian Journal of Language and Literacy*, 33(3), 211-239.
- Williams, W. R. (2014). New technologies, new possibilities for the arts and multimodality in English language arts. *Contemporary Issues in Technology and Teacher Education*, 14(4), 327-355.
- Wurman, R. S. (1989). *Information anxiety*. New York, NY: Doubleday.

- Van Heertum, R. & Share, J. (2006). A new direction for multiple literacy education. *McGill Journal of Education*, 41(3), 249-265.
- Vanichvasin, P. (2013). Enhancing the quality of learning through the use of infographics as visual communication tool and learning tool. In IQCA '13 (pp. 135–142). Ratchathewi, Bangkok. Retrieved from:
http://www.icqa2014.com/downloads/Proceeding_29.pdf#page=135
- Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Appendix A: Letter of Introduction & Consent Forms

LETTER OF INTRODUCTION

My name is Lauren Fridman, and I am a graduate student at the Faculty of Education at the University of Ontario Institute of Technology (UOIT). With the approval of the UOIT Research Ethics Board [REB #14131, approved on February 2, 2017], I am about to begin my thesis research. The focus of this project is to investigate the impact of reading and creating infographics with beginning teacher candidates (TCs). Information graphics, referred to more commonly as infographics are a type of visual that blends data and design, which helps individuals, groups, and organizations more clearly communicate complex messages to their target audiences (Smiciklas, 2012). The primary goal is to explore the affordances and constraints of both consuming and producing infographics and determining whether/how these TCs might use this relatively new form of multimodal communication/expression with their future pupils. Infographics allow students/creators to express their understanding through multimodal methods, allowing the development of a wide array of skills including traditional literacy as well as 21st century competencies such as digital literacies.

It is projected that the information that comes from this research will be used for the development of future lessons, which may raise the awareness and increase the likelihood of implementation of infographics and similar communication tools in Ontario classrooms. Data results will also be presented as a graduate level thesis.

I invite you to participate in this study. All participants will be able to explore this relatively new communication tool. Participants will also be required to create a project that exhibits their understanding of an issue of personal importance to them (e.g. Mental Health, The Truth and Reconciliation Commission, etc.) in the form of an infographic. Your participation would involve the following: (1) completion of a 15-20 minute online pre-survey; (2) a ranking activity at the Faculty of Education of pre-created infographics; (3) submission of your own infographic artifact based off of your topic of interest to the primary investigator; and (4) a 15-20 minute 1-on-1 interview with the primary investigator following the submission and analysis of the participant-made infographic. Data will be collected at different times throughout the course of the study. However, data collected will only be used for analysis and reporting from those participants who have provided consent. The primary investigator will take unobtrusive

observation notes during the sessions. These notes will be shared with the participant prior to any publication to ensure accuracy of information.

Participation in this research project is completely optional and there will be no academic penalty for not participating. The following methods will be used for data collection:

- Participants will complete a pre-study questionnaire to assess their understanding and engagement with current digital tools as well as infographics more generally. The questionnaire will take roughly between 15-20 minutes to complete. Analysis will be conducted based on the responses provided by participants, and the findings will be used for discussion purposes later on. These responses will also be used as a baseline for tracking participants' views of infographics and 21st century competencies change and/or develop over the course of the study.
- The PI will collect participant data through observation notes and audio/video recording.
- The PI will collect data through 1-on-1 interviews with selected participants at the beginning and conclusion of the study to track any changes in perspective as well as to gain a better understanding of those perspectives identified through observation. Interviews will take place in the UOIT Faculty of Education.

There are very limited risks for participating in this study. Participants may be standing or sitting for extended periods of time. To mitigate this risk, frequent breaks are suggested.

Participants may withdraw from the study at any time without penalty and can choose not to answer specific questions by saying, “pass” in any interview setting. If, during any of the above activities, you decide not to participate, you can stop the activity by approaching the researcher and indicating that you wish to withdraw from the study. You will be notified if any activity or discussion is being taped and will have the opportunity to object. The information provided will be accessible only to the researcher and her supervisor. Each participant will be assigned a pseudonym once the data has been collected and any images or videos where the participants are visible will be altered to obscure the faces. Any names present on participant work will be removed prior to publication.

The tapes and transcripts, as well as all other data collected will be stored securely with the researcher. By consenting to participate, the participant does not waive any normal legal rights or recourse.

Your signature on the consent form indicates that you have read this letter, understand its contents, and agree to participate in this research study. If you have any questions regarding the study or experience any discomfort related to the study, please contact the researcher Lauren Fridman at lauren.fridman@uoit.net.

Any questions regarding your rights as a participant, complaints or adverse events may be addressed to the Research Ethics Board through the Ethics and Compliance Officer – researchethics@uoit.ca or 905.721.8668 ext. 3693.

Thank you for considering participation in this research study.

Lauren Fridman

CONSENT FORM

Participant Concerns and Reporting:

If you have any questions regarding the study or experience any discomfort related to the study, please contact the researcher Lauren Fridman at lauren.fridman@uoit.net.

Any questions regarding your rights as a participant, complaints or adverse events may be addressed to Research Ethics Board through the Ethics and Compliance Officer – researchethics@uoit.ca or 905.721.8668 x. 3693.

This study has been approved by the UOIT Research Ethics Board REB #14131 on February 2, 2017.

Participant:

I have read the Letter of Introduction – Request for Consent relating to the above titled project, I understand the proposed research and my questions must be answered to my satisfaction.

I understand and consent to the following (please check each item you understand and agree to):

- ☐ I have the right to withdraw from the study at any time if I do not feel comfortable and I understand that the information collected is for research purposes only and no personal identifiers will be used.
- ☐ If I withdraw, my information will not be used in the research and will be destroyed.
- ☐ Participation is entirely voluntary and that choosing to participate or choosing to withdraw from the study will have no negative consequences for me.
- ☐ Data will be collected through field notes and audio/visual/photo recordings. All notes and interview transcripts will be shared with participants for verification before any findings are analyzed and disseminated. I can choose to withdraw my contributions or clarify items with no negative consequences.

- ☐ I understand that there are limited physical risks involved in this study.
- ☐ I understand that I will be instructed through each step of the research project and that I have the right to pass and not share one or all of the projects I create. There will be no negative consequences if I choose not to share.

By signing below, I give my consent for participation in the research study.

I give consent to be recorded (audio/video/photo): ☐

I give consent to be audio-recorded only: ☐

I give consent to be video-recorded only: ☐

I give consent to be photographed only: ☐

I give consent to the secondary use of data: ☐

I give consent to participate in the focus groups: ☐

I give consent to participate in the interviews: ☐

Full Name (please print): _____

Signature: _____

Date: _____

Email: _____

Note: Please return this document to Lauren Fridman in the STEAM 3D Makerspace Lab (room 415) by March 31, 2017. If you cannot make it to the lab to return the document, please arrange a meeting with Lauren through lauren.fridman@uoit.net. A photocopy of this document will be made so that you can retain a copy for your records.

Researchers Name: Lauren Fridman

Signature: _____

Date: _____

Appendix B: Pre-Research Questionnaire

1. What does the term “Literacy” mean to you? How would you define it?
2. What does the term “Digital Literacy” mean in your own words?
3. Would you consider yourself digitally literate? Explain.
4. What do you identify as “21st century competencies” that should be taught in the classroom? How can you be sure that these are addressed in your future classroom?
5. Have you ever used an infographic before? Yes/No
 - a. If you answered yes to the above question, what was the context?
 - b. What was the process like for you?
 - c. Have you ever used them in an educational setting? (i.e. reading one, critiquing one, creating one).
6. How might an infographic fit into the digital literacy definition you used above?
7. How might an infographic encourage literacy development in school? How might infographics enhance the teaching/learning process?
8. How confident do you feel in your abilities with infographics and related tools? How do you feel your current understanding of digital literacies will impact your successes in the tasks involved in this study?

Likert Scale Questions

I am confident using digital technology in my teaching **1 2 3 4 5 6 7**

I am digitally literate **1 2 3 4 5 6 7**

My teaching practice includes 21st century competencies **1 2 3 4 5 6 7**

Students enjoy learning literacy with traditional methods **1 2 3 4 5 6 7**

Multiple communication methods are available for students to express their understanding in literacy classrooms **1 2 3 4 5 6 7**

I am comfortable using infographics **1 2 3 4 5 6 7**

I enjoy using infographics in my teaching **1 2 3 4 5 6 7**

Infographics could be used to teach literacy to students **1 2 3 4 5 6 7**

If you have any questions, comments or concerns, please outline them here.

Appendix C: One-on-One Interview Questions

Thank you for participating in my study and for agreeing to participate in this interview. Just to remind you of a few things -- you may withdraw from the study at any time without penalty and you can choose not to answer specific questions by saying, "pass". If you decide you do not want to participate, you can stop me (the interviewer) by letting me (the interviewer) know you do not wish to participate any longer. You can choose what, if any, of the interview you would like to be included in the study/data collection. Any information you indicate can be included will be accessible to the research team (myself and my supervisor) only and kept in a secure location (with the primary investigator). Pseudonyms will be assigned to every participant.

In the interviews, I will follow up with participants on important and note-worthy items that have emerged in the ranking activity and from the pre-survey questionnaire. Items I anticipate expanding on include:

- Individual technology use/21st century competencies and/or skills gained
- Lessons learned from the infographic making process (intra-personal lessons learned, subject-specific lessons learned, etc.)
- Specific examples/details regarding how infographics might benefit learning and/or encourage engagement in the literacy learning process
- Subject-specific examples of how one could integrate technology, infographics and/or 21st century competencies in his/her current or future classroom(s)

INFOGRAPHIC OF INFOGRAPHICS

Data visualization is a popular new way of sharing research. Here is a look at some of the visual devices, informational elements, and general trends found in the modern day infographic.

DESIGN

CHART STYLE

Percentage of infographics with the following charts:

Chart Style	Percentage
Pie Chart	22%
Pictorial Chart	24%
Line Chart	24%
Bar Chart	32%

FONT

Frequency of arrows & connecting lines in infographics:

Font Style	Percentage
Sans Serif	85%
Condensed Sans Serif	15%
Serif	15%

NAVIGATIONAL ICONOGRAPHY

Frequency of arrows & connecting lines in infographics:

Iconography Type	Percentage
arrows	13%
lines	38%
both	13%

BASE COLOR

KEY INFO

Percentage of infographics with key:

Average number of symbols per key: 5.1

CONTENT

COUNTRIES FEATURED

Country	Percentage
United States	88%
China	22%
United Kingdom	12%
Australia	12%
Canada	10%
India	10%
France	10%
Mexico	8%

THEME

Relative popularity of different infographic themes:

SECTIONS

AVERAGE NUMBER OF SECTIONS: 2.02

CREDITED SOURCES

Average number of sources per infographic: 2.29

TITLE

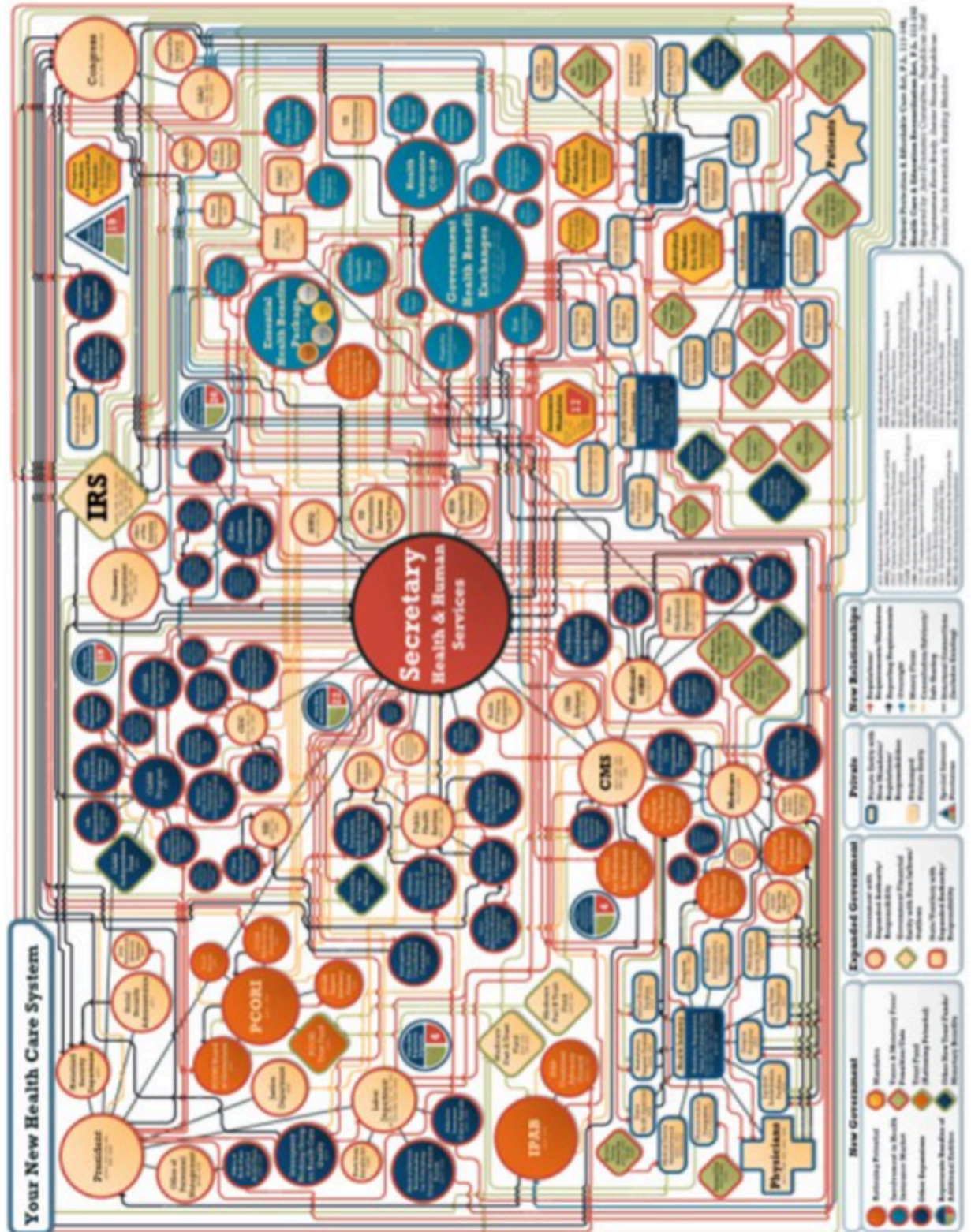
Average number of words per infographic title: 4.36

"RICHEST AND POOREST AMERICAN NEIGH"

Infographic B



Infographic C



Appendix E: Infographic Ranking Questions

1. Why did you rank the infographics in the order you did?
2. What stood out to you about infographic A?
3. What stood out to you about infographic B?
4. What stood out to you about infographic C?
5. What would you say are the most important things to consider when creating or sharing an infographic?
6. How would you improve the infographic you ranked lowest?
7. What are some areas of infographic creation that you think students will have trouble with?
8. What are some areas of infographic creation that you think students will enjoy or thrive at?
9. How do you think infographics encourage the development of digital literacies skills?
10. How do you think creating infographics intersect with the development of 21st century competencies (collaboration, communication, inquiry skills, problem solving, etc.)

Appendix F: Teacher Candidate Created Infographics

Phillip



Luke



Every Tree Counts: Growing Toronto's Urban Forest



Key Findings

Toronto has approximately 26.6 - 28% urban tree canopy cover, representing 10.2 million trees. The urban tree canopy is a vital city asset with an estimated structural value of \$7.1 billion.

Private property in Toronto has the greatest potential to grow the urban tree canopy cover.

#CityGoals

To increase the City's tree canopy to 40% over the next 50 years.

To meet this target, 300,000 new trees must be planted in Toronto each year.



Why?



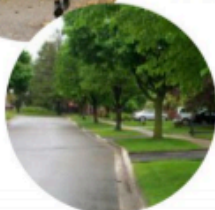
Combat Climate Change

The urban forest can absorb greenhouse gas emissions which helps slow global temperature rise. The city's urban forest helps mitigate the impacts of climate change by sequestering and storing carbon.



Improve Social Health

Contact with nature is associated with health benefits such as lower blood pressure and cholesterol levels, enhanced survival after a heart attack, more rapid recovery from surgery, fewer minor medical complaints and lower self-reported stress.



Improve Social Wealth

Research has shown that appraised property values of homes that are adjacent to parks and open spaces are typically higher than those of comparable properties elsewhere. A Toronto-based found having even 10 more trees on your block is tantamount to a \$10,000 deposit in your bank account.

Sources:

Every Tree Counts: A Portrait of Toronto's Urban Forest, https://www1.toronto.ca/City%2009K20Toronto/Parks%20Forestry%20&%20Recreation/Urban%20Forestry/Files/pdf/Every_Tree_Counts.pdf
Toronto Parks and Trees Foundation: Every Tree Counts, <http://www.everytreecounts.ca/>

Jake


Cracking the Learning Code

The Meaning Network

Transforming how we learn and how we behave

A more in-depth background on how this science is completely transforming the paradigm for those of us that are in education and business development. Using this research to propel our education development into principles of neurology that work together with not against the students brain.

The purpose of the following infographic is to provide you with some of the principles of neurology that if put into place in education, will transform the learning capacity for all students learning in the classrooms.

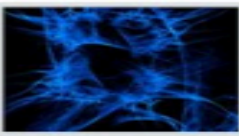


01 The Brain is a selector of information

The brain as a selector of information based on prior knowledge and interest based on relevance comparison to already selected information into the brain.

The brain selects information when we are intrinsically not extrinsically motivated.

How/what does the brain select?




02 Prioritizing Information


Information that your brain reveals as meaningful, must first be prioritized in working memory, before movement into long term memory.

It prioritizes information based on the intensity of emotional and somatic feedback.

Inclusion into its space is dependent upon information that the brain already holds as meaningful.



03 Attributes of the Meaning Network



No learning occurs without an emotional response.

No learning occurs without a somatic response for the body.

No learning occurs without opportunity to select based on what is relevant.


04 The Meaning Network - "the Holy Grail of Learning"

Before new information can be efficiently selected, it must first stimulate a group of neurological structures, called the "Meaning Network". The Meaning Network first tags information that will be valuable to our survival with emotional and somatic marking (feedback from body and organs).


Depression/dopamine intrinsic reward circuits:
Neurotransmitters released during meaningful stimulus to enhance your attention towards that stimulus.

Without emotion there can be no long term memory formation:
Emotions amplify the information tagging process.
Are emotions important to the learning process.

No Learning without feedback from the body:
When the brain receives taste, touch, smell, and sound stimuli, it immediately sends this information to the body, which, in turn, feeds back signals to the brain.
Learning must involve active learning activities.
Learning activities that are relevant to the real world.



05 Transforming the future of education



Understanding the brain, and the patterns that support/enhance long term memory formation, can help us shift the paradigm into classroom instruction.

Learning activities must provide opportunity for students to find personal meaning and real world meaning in the tasks.

The information within this infographic is based on research done by the Advanced Learning Institute. Many of the images within the infographic are also those created by the Advanced Learning Institute and/or associated partners.

<http://www.advancedlearningcode.com/>

Infographic created using piktochart

Eric



Appendix G: Post-Study Interview Questions

General Questions:

1. Has your opinion of using infographics changed over the course of this study?
2. What affordances do you perceive for the use of infographic production and consumption?
3. What constraints do you perceive for the use of infographic production and consumption?
4. How do you think creating infographics help to encourage digital literacy skill development? What about learning from them?
5. Do you believe that infographic creation encourages 21st century skill development (multimodal communication, creative and critical thinking, collaboration, problem solving and cultural and global citizenship)? If so, how?
 - a) What specific skills do you think students gain through the production and consumption of infographics?
6. How do you see yourself using infographics in your own teaching? Have you used them in your teaching since beginning this study?
7. Do you feel that the infographic teaches similar skills as a traditional essay? If so, how?

Individual Questions:

Phillip

1. In our initial interview, you mentioned the importance of referencing data. I notice that you listed the websites at the bottom of the infographic, do you think that is enough?
 - a) Should you be using proper APA/MLA style referencing? What about in-text citations?
2. You mentioned in our interview that the length could be a factor for readers continuing or skipping your infographic, do you think that your infographic was an appropriate length?
3. Do you feel that you had too much text in your infographic?

Luke:

1. In our initial interview, you mentioned the importance of referencing data. I notice that you listed the websites at the bottom of the infographic, do you think that is enough?
 - a) Should you be using proper APA/MLA style referencing? What about in-text citations?
2. Do you feel that you had too much text in your infographic?
 - b) Could you have better spread out or broken down the text too make it easier to absorb?

Eric:

1. Do you feel that your text to image/graphic ratio was appropriate?
2. Who was the target audience for your infographic? Do you feel there was a way you may have been able to clarify this further?

3. What was the purpose of the infographic you created? Do you think this was clear based on the information you presented?
4. In our initial interview you mentioned the importance of legitimate data, why do you feel this way?
 - a) I noticed that you did not make any references in your infographic, was all the information from memory or should you have sourced the material in the infographic?
 - b) Do you feel that images should be sourced as well?
5. Do you think that collaboration can only exist person-to-person, or is there an element of collaboration that exists person-to-technology? Explain.

Jake

1. We discussed digital citizenship as a key 21st century skill to be developed by students, part of that includes sourcing data. Do you think it is important to use APA/MLA citations in an infographic? What about in-text citations?
 - a. What about in-text citations?
2. Do you think the length of your infographic was appropriate? Why or why not.

Appendix H: Post-Study Questionnaire

1. What does the term “literacy” mean to you? How would you define it?
2. What does the term “digital literacy” mean in your own words?
3. Has your opinion of using infographics in the classroom changed over the course of this study?
4. How might an infographic encourage literacy development in school?
5. How might infographics enhance the teaching/learning process?
6. What benefits do you see in the use of infographics in the classroom?
7. What constraints do you see in the use of infographics in the classroom?
8. How did creating an infographic help you develop your digital literacies skills?
9. Do you believe that creating infographics involves the use of 21st century skills? If so, how? (Please be as specific as you can).
10. How do you think you will use infographics in your future teaching?
11. Has your opinion of this communication tool changed at all over the course of this study? If so, how?
12. Is there any further information you would like to share with me about the study?

Appendix I: Written Thank You Letter (Email)

Dear _____,

I would like to thank you for participating in my study. Through your participation I have learned a lot about infographics, their use in education and how 21st century competencies are present in our future teachers. The aggregate information collected may be used in future infographic research, and I will be completing my thesis with this information.

Since I told you at the beginning of the study that you would be able to read all the information collected on you during the study, please find a copy of all these documents attached. The information in the transcript is verbatim, with the only changes being that your name has been removed and replaced with a pseudonym, as has everything else that might identify you. If there is anything in the transcript that you believe is incorrect or if you may have additional comments to make, please send back a revised copy of the transcript.

If you have any further questions, concerns or comments about the data collected or how it will be used, please feel free to contact me at lauren.fridman@uoit.net.

Any questions regarding your rights as a participant, complaints, or adverse events may be addressed to the Research Ethics Board, UOIT, through the Research Ethics Coordinator - researchethics@uoit.ca or 905.721.8668 x. 3693".

Thank you again for your time and participation,

Lauren Fridman

Appendix J: Teacher Candidate Recruitment Email

My name is Lauren Fridman, and I am a graduate student at the Faculty of Education at the University of Ontario Institute of Technology (UOIT). With the approval of the UOIT Research Ethics Board [REB #, approved on **** date], I am about to begin my thesis research. The focus of this project is to investigate the impact of reading and creating infographics with beginning teacher candidates (TCs). The primary goal is to explore the affordances and constraints of both consuming and producing infographics and determining whether/how these TCs might use this relatively new form of multimodal communication/expression with their future pupils.

I invite you to participate in this study. All participants will be able to explore this relatively new communication tool. Participants will also be required to create a project that exhibits their understanding of an issue of personal importance to them (e.g. Mental Health, The Truth and Reconciliation Commission, etc.) in the form of an infographic.

Your participation would involve the following:

1. Completion of a 15-20 minute online pre-survey;
2. A ranking activity at the Faculty of Education of pre-created infographics;
3. Submission of your own infographic artifact based off of your topic of interest to the primary investigator; and
4. A 15-20 minute 1-on-1 interview with the primary investigator following the submission and analysis of the participant-made infographic.

The tapes and transcripts, as well as all other data collected will be stored securely with the researcher. By consenting to participate, the participant does not waive any normal legal rights or recourse.

If you are interested in participating in this research study, please email lauren.fridman@uoit.net with your name and whether you are a P/J or I/S Candidate.

Thank you,

Lauren Fridman

Appendix K: Research Ethics Board (REB) Approval

Date: February 02, 2017

To: Janette Hughes

From: Shirley Van Nuland, **REB** Chair

File # & Title: 14131 - Examining the Affordances and Constraints of Using Infographics in Education

Status: **APPROVED**

Current Expiry: February 01, 2018

Notwithstanding this approval, you are required to obtain/submit, to UOIT's Research Ethics Board, any relevant approvals/permissions required, prior to commencement of this project.

The University of Ontario, Institute of Technology Research Ethics Board (**REB**) has reviewed and approved the research proposal cited above. This application has been reviewed to ensure compliance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2 (2014)) and the UOIT Research Ethics Policy and Procedures. You are required to adhere to the protocol as last reviewed and approved by the **REB**.

Continuing Review Requirements (all forms are accessible from the [IRIS research portal](#)):

- **Renewal Request Form:** All approved projects are subject to an annual renewal process. Projects must be renewed or closed by the expiry date indicated above ("Current Expiry"). Projects not renewed 30 days post expiry date will be automatically suspended by the **REB**; projects not renewed 60 days post expiry date will be automatically closed by the **REB**. Once your file has been formally closed, a new submission will be required to open a new file.
- **Change Request Form:** Any changes or modifications (e.g. adding a Co-PI or a change in methodology) must be approved by the **REB** through the completion of a change request form before implemented.
- **Adverse or Unexpected Events Form:** Events must be reported to the **REB** within 72 hours after the event occurred with an indication of how these events affect (in the view of the Principal Investigator) the safety of the participants and the continuation of the protocol (i.e. un-anticipated or un-mitigated physical, social or psychological harm to a participant).
- **Research Project Completion Form:** This form must be completed when the research study is concluded.

Always quote your **REB** file number (**14131**) on future correspondence. We wish you success with your study.

Dr. Shirley Van Nuland
REB Chair
shirley.vannuland@uoit.ca

Janice Moseley
 Research Ethics Coordinator
researchethics@uoit.ca

Appendix L: Research Ethics Board (REB) Renewal

Date: January 10, 2018

To: Janette Hughes

From: Janice Moseley, Research Ethics Officer

File # & Title: 14131 - Examining the Affordances and Constraints of Using Infographics in Education

Status: RENEWAL APPROVED

***Current Expiry:* February 01, 2019**

The above-noted research ethics file has been renewed. You are required to continue to adhere to the protocol as last reviewed and approved by the Research Ethics Board (REB) at the University of Ontario Institute of Technology (UOIT).

This research is subject to continuing review requirements. This research file must be renewed or closed by the current expiry date (February 01, 2019) by using the following forms from the [IRIS research portal](#).

- **Renewal Request Form:** All approved projects are subject to an annual renewal process. Projects must be renewed or closed by the expiry date indicated above ("Current Expiry"). Projects not renewed 30 days post expiry date will be automatically suspended by the REB; projects not renewed 60 days post expiry date will be automatically closed by the REB. Once your file has been formally closed, a new submission will be required to open a new file.
- **Change Request Form:** Any changes or modifications (e.g. adding a Co-PI or a change in methodology) must be approved by the REB through the completion of a change request form before implemented.
- **Adverse or Unexpected Events Form:** Events must be reported to the REB within 72 hours after the event occurred with an indication of how these events affect (in the view of the Principal Investigator) the safety of the participants and the continuation of the protocol (i.e. un-anticipated or un-mitigated physical, social or psychological harm to a participant).
- **Research Project Completion Form:** This form must be completed when the research study is concluded.

Always quote your REB file number (14131) on future correspondence. We wish you continued success with your study.

NOTE: If you are a student researcher, your supervisor has been copied on this message.

Appendix M: Tri-Council Policy Statement on Ethics (TCPS2: Core)

